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The Classic Orders of Architecture

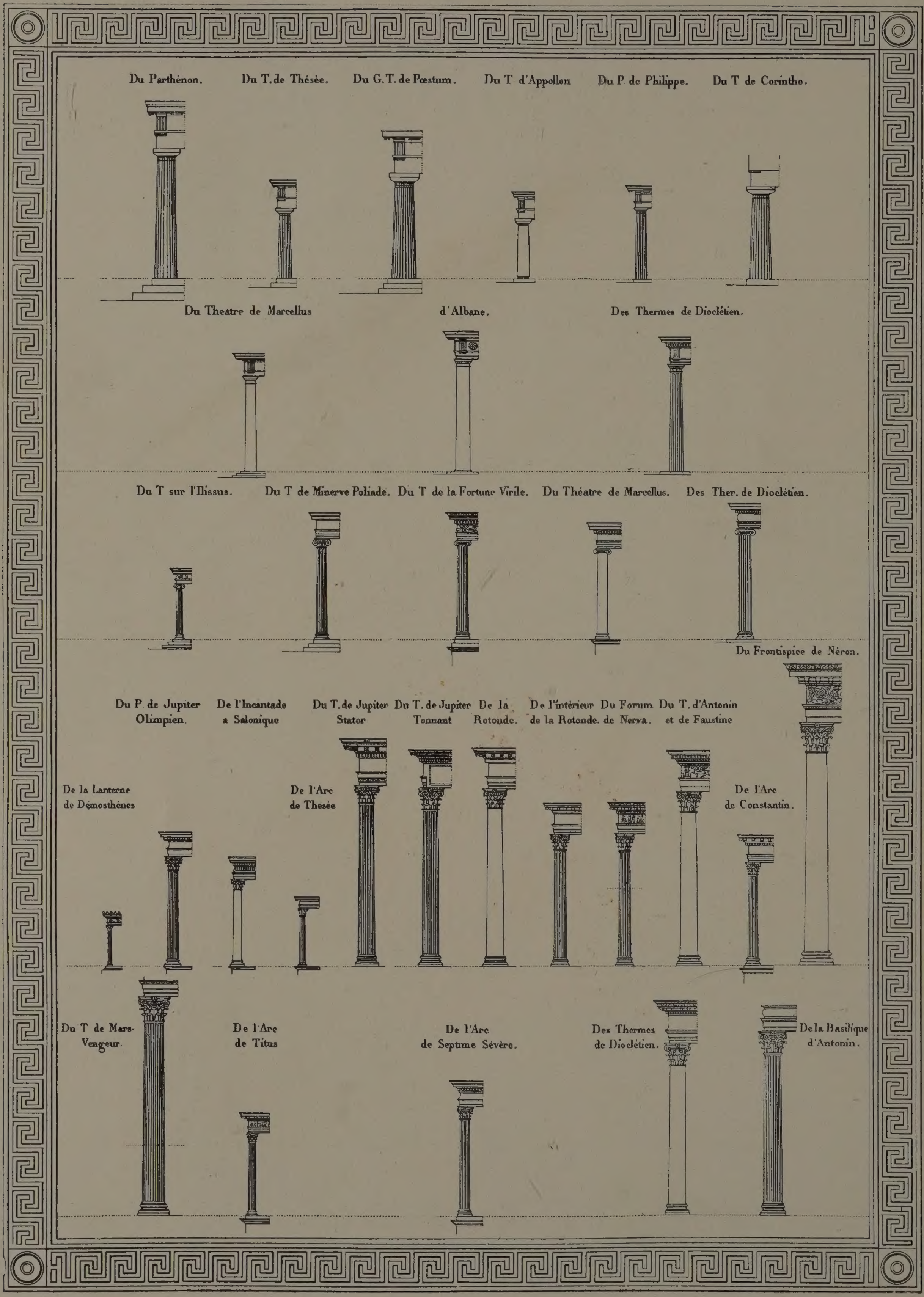
By Egerton Swartwout, F.A.I.A.

The following is the beginning of a series of articles which will appear monthly on the classic orders.

INTRODUCTION.

IT is universally accepted that the term Classic in architecture is limited in application to those temples and monuments which date from the best period of Greek and Roman art—a comparatively short period, as history goes, lasting in Greece only about one hundred and fifty years, from the time of the Persian invasion to the time of Alexander, and approximately double that length of time in Rome, from the time of Cæsar to that of Diocletian. That the monumental temples of Egypt and the palaces of Assyria and Persia are refused the distinction of classicism is possibly due to the fact that they did not appeal to the taste of the Renaissance writers, and possibly also to the fact that at that time they were comparatively unknown. Whether to this empirical classification can be attributed the general neglect of Egyptian art by the architectural profession, or whether this neglect has been due to a feeling that the Egyptian is less adaptable to modern purposes than Grecian or Roman, is not within the province of this article to discuss; still there is so much that is monumental in the Egyptian plans, interiors and methods of lighting, and so much that is fine in the simplicity of their orders, that it is strange and to be regretted that no serious effort has been made to adapt to the requirements of the present a monumental grandeur that has never been equalled in the past.

It has been said that the history of a country can be read in its architectural remains, and this is pre-eminently true of Greece and Rome. The development of the Doric temple from the crude forms of the Eighth Century to the marvelous proportions and subtle refinements of the Periclean age are coeval with the advancement of Greece in wealth and learning, as well as in the allied arts of painting and sculpture. The glory of Greece in commerce and in art was a gradual development from Mycenian civilization, just as the squat columns and overwhelming entablatures of the early temples are the stepping stones to the proportions of the Parthenon. This gradual development and ultimate perfection was possible in Greece to an extent achieved seldom in Rome and



PARALLEL OF THE CLASSIC ORDERS.

scarcely at all in modern times. The Greek architect was working along the simplest lines and with the simplest forms, and practically with one order, the Doric—and by all succeeding ages it is acknowledged that he alone of all architects has approached the absolute. No one has ever built a better Doric exterior than the Parthenon, nor is it probable anyone ever will.

If, then, it is true that the history of a country can be read in its architecture, how regrettable it is that we cannot read more thoroughly the history of that ar hitecture itself. How regrettable is the almost total destruction of these ancient monuments, not so much by the ravages of time as by the ignorance and greed of man; and how equally regrettable is the fact that the written records of Classic Architecture are almost negligible; and it is because of the paucity of these records that we must needs build up our present-day knowledge of that architecture from the buildings themselves; and this knowledge must rise phoenix-like from the ruins, for, unfortunately, these monuments are in such a ruinous state that their restoration is not only difficult, but in some cases problemati al or impossible. Of the older temples, many have completely disappeared, and our knowledge of their existence is confined entirely to a few straggling inscriptions and to references in the works of early Greek and Roman writers. Others have been uncovered by the excavations in recent years, and there has been found only enough of the foundations and fragments of columns to make their restoration a source of contention among archeologists. In places the structure has been entirely overthrown by earthquakes, and nothing is left but a mass of weather-beaten stones, piled in confusion around the site; and in such cases as these it is almost an impossibility even to determine with exactitude the height of the order. Had the columns of antiquity been constructed in accordance with our modern method, with drums of equal height, their restoration would be comparatively simple; but with unequal drums the only method of arriving at this height is by a careful computation of the entasis, a method which on account of the flatness of the curve is difficult of application, and has on occasion resulted in divergencies of nearly two feet. The extreme difficulty in taking accurate measurements under such circumstances can be appreciated by any one who has attempted to measure carefully buildings that are in a fairly completed condition. Almost invariably the drums that have been found are so weather-worn and broken that the only way that accurate measurements can be obtained is from the depth of the flutes, and these measurements are naturally not as accurate in determining the entasis as those taken from the arris, for on account of the diminution in depth the line of entasis taken on the depth of the flutes is not the same curve as the entasis taken on the arris, and further, as the arris alone gives the outline of the column, usually less care is expended on the cutting of the depth of the flutes; and as even in the Parthenon none of the columns are exactly the same size, a comparison of the entases of several columns becomes of questionable value.

Another disconcerting fact is the utter absence of any remains other than stone, or in some instances terra cotta. The bronze and more precious metals have long since been stolen, and the wood, which formed a greater part of the roof and ceiling, has absolutely disappeared; and as in many of the very ancient temples it is probable that not only was the roof and ceiling of wood, but that also the entire entablature was formed of this material, any restoration becomes entirely a matter of conjecture and individual opinion.

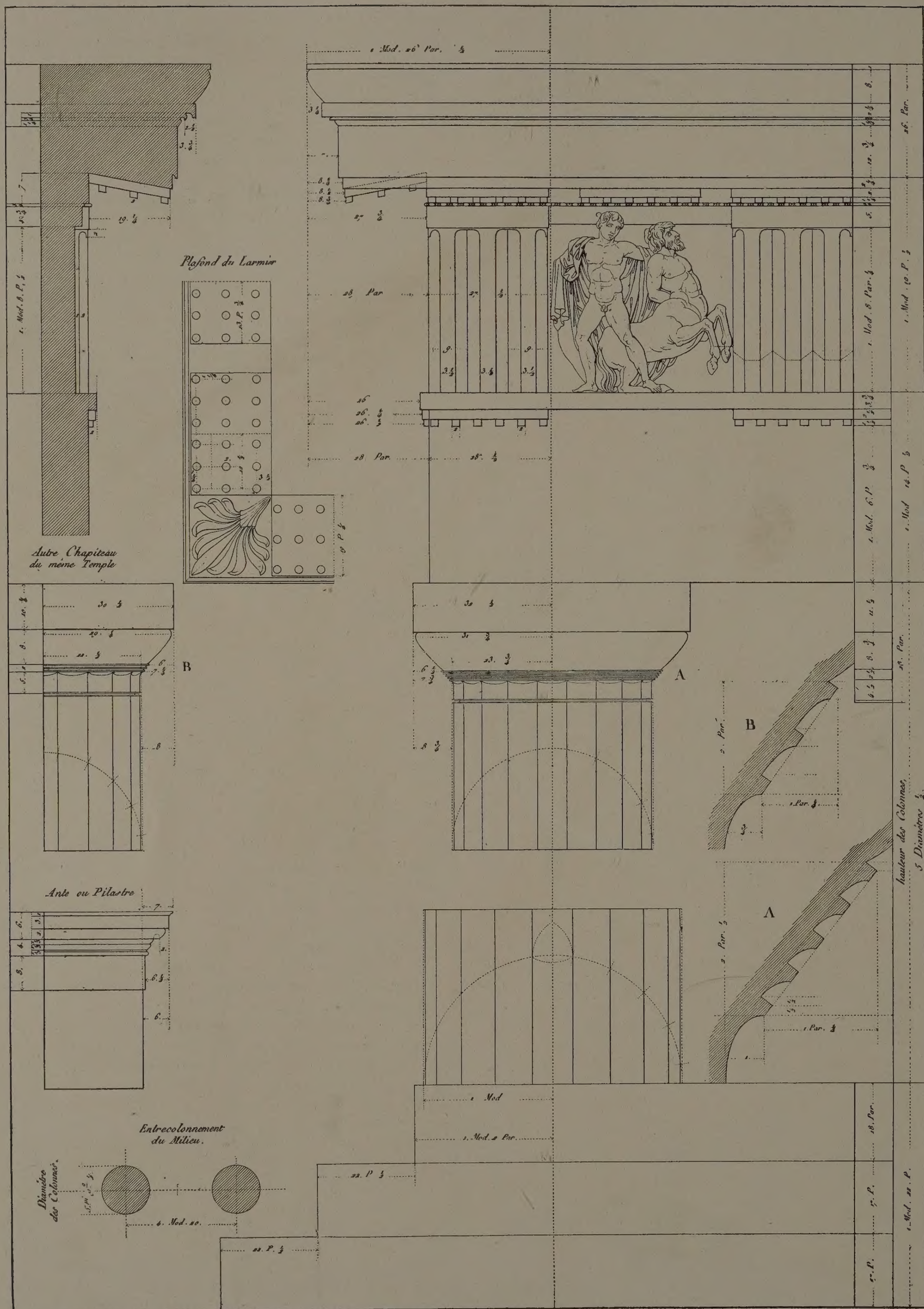
Fortunately, much of the remains of the more important temples are standing, and their restoration can be accomplished with more or less certainty. From the measurements of Penrose we can with confidence restore the columns, entablature and walls of the Parthenon, the Erechtheion, and the so-called temple of Theseus. Other monuments in Athens, as well as certain temples in Sicily and Magna Grecia can be restored with general accuracy. In no case, however, has there been a positive agreement as to the roofing and method of lighting, the latter especially having been the subject of greatest controversy for the last century and a half.

In this most interesting, but little pursued, study of the remains of antiquity, a study which unfortunately has been confined chiefly to archeologists, two most regrettable facts present themselves, the first that until a few hundred years ago these monuments, especially in Greece, were in a fairly perfect state, and secondly, that there exists no contemporaneous description which can be followed as a guide in their restoration. We know that it was often customary for the architect to leave written records of the buildings he had erected. We know that Ictinos wrote a monograph on the Parthenon, and possibly on his extremely interesting temple at Bassae. There were descriptions of the Erechtheion and of the Propylæa and of some of the later temples, and yet none of these records have been preserved to us, with the exception of some inscriptions which refer to the cost and construction of the Erechtheion, and a fairly complete specification of an arsenal built much later in the Piræus.

If we could imagine that the writings of Ictinos were personal records or that they covered in detail the now disputed points in the construction of the Parthenon; if we could imagine them his own account of his struggles and achievements, of his first conceptions of the work and of the changes that were undoubtedly forced on him by those in control; if we could learn at first hand his reasons for the adoption of a proportion for his columns and his entablature slightly different from those of their prototypes, his ideas regarding entasis and the inclination of the column, his study of the lighting problem, and the extent of the color decorations, all this would make the most fascinating reading and would prove of incalculable benefit to the architectural profession now. The only consolation that is left to us is that these descriptions were probably impersonal; they may have dealt only with the history of the construction of the building, its progress and probable cost; in other words, they may have been merely reports which were submitted to the officials in Athens, similar in many respects to the reports submitted by architects of modern times. If this is the case, we can only feel that we have lost an interesting document, and not a priceless contribution to the literature of architecture.

It is true we have an occasional reference to contemporaneous buildings in Herodotus or in the Greek poets of the Periclean age. These references, however, are slight, and have chiefly been used by archeologists to combat the views advanced by some one else, and have no real architectural value. At a very much later date we have the writings of Pausanias, a Greek from Asia Minor, who in the time of Hadrian made extensive travels and observations throughout the then known world. He was not an architect, and although his observations of localities and buildings are valuable and interesting, they are not of very great service to the archeologist.

Practically the only Classic author whose writings on architectural matters have come down to us and who was himself an architect was M. Vitruvius Pollio, who lived and wrote in the time of Cæsar and Augustus, and is better known as Vitruvius, sometimes called the Father of Architecture. Vitruvius seems to have been more of an engineer than an architect; in fact, he does not seem to have made much of a success



THE DORIC ORDER OF THE PARTHENON.

at the latter profession, although his book is a palpable attempt to bring himself to the favorable notice of Augustus. This he admits, and instances the case of a Greek architect named Dinocrates, who, being extremely anxious to attract the favorable notice of Alexander the Great, and who, "having divested himself of his garments, annointed himself with oil, and clad in a lion's skin, with a wreath of poplar on his head and an enormous club in his hand," created such a sensation that he was promptly awarded the commission to build the City of Alexandria. Vitruvius felt that this strenuous policy of the big stick was not suited to his physique, for he says, "But to me, Emperor, Nature hath denied an ample stature; my face is wrinkled with age, and sickness hath impaired my constitution." Later, in Book VI, there is an indication of disappointment, not unmixed with jealousy, at his non-success, which he attributes to his high ethical standards. The passage is interesting, because it shows that the modern method of obtaining work is a distinct inheritance. "But I, O Cæsar, have not sought to amass wealth by the practice of my art, having been rather contented with a small fortune and reputation than desirous of abundance accompanied by want of reputation. It is true that I have acquired but little, yet I still hope by this publication to become known to posterity." "Neither is it wonderful," he says, "that I am known to but a few. Other architects canvass and go about soliciting employment, but my preceptor instilled into me a sense of the propriety of being requested and not of requesting to be intrusted, inasmuch as the ingenuous man will blush and feel ashamed in asking a favor."

His book is indeed a most remarkable production. He describes in detail how to lay out a city to take advantage of the most salubrious breezes, how to make ballistae and other engines of war, how to apply stucco in damp places, and how to manufacture colors, how to lay out sun dials, and what kind of water is best adapted to the cure of internal ills; and indeed, he has a great deal to say about water, for he says in Book VIII, "Some springs appear to be mixed with wine, as that in Paphlagonia, which when taken, inebriate as wine," and again, "In Arcadia, at the well-known city of Clitorium, is a cave flowing with water, of which those who drink become abstemious." It is encouraging to know that there was an antidote, to which, however, the distance between Paphlagonia and Arcadia was somewhat of a deterrent. Pursuing still further the same subject, he says, "On the contrary, in a champagne country much water will not probably be found," although it may be that the aptness of the latter allusion is an unconscious contribution of Mr. Gwilt, the translator.

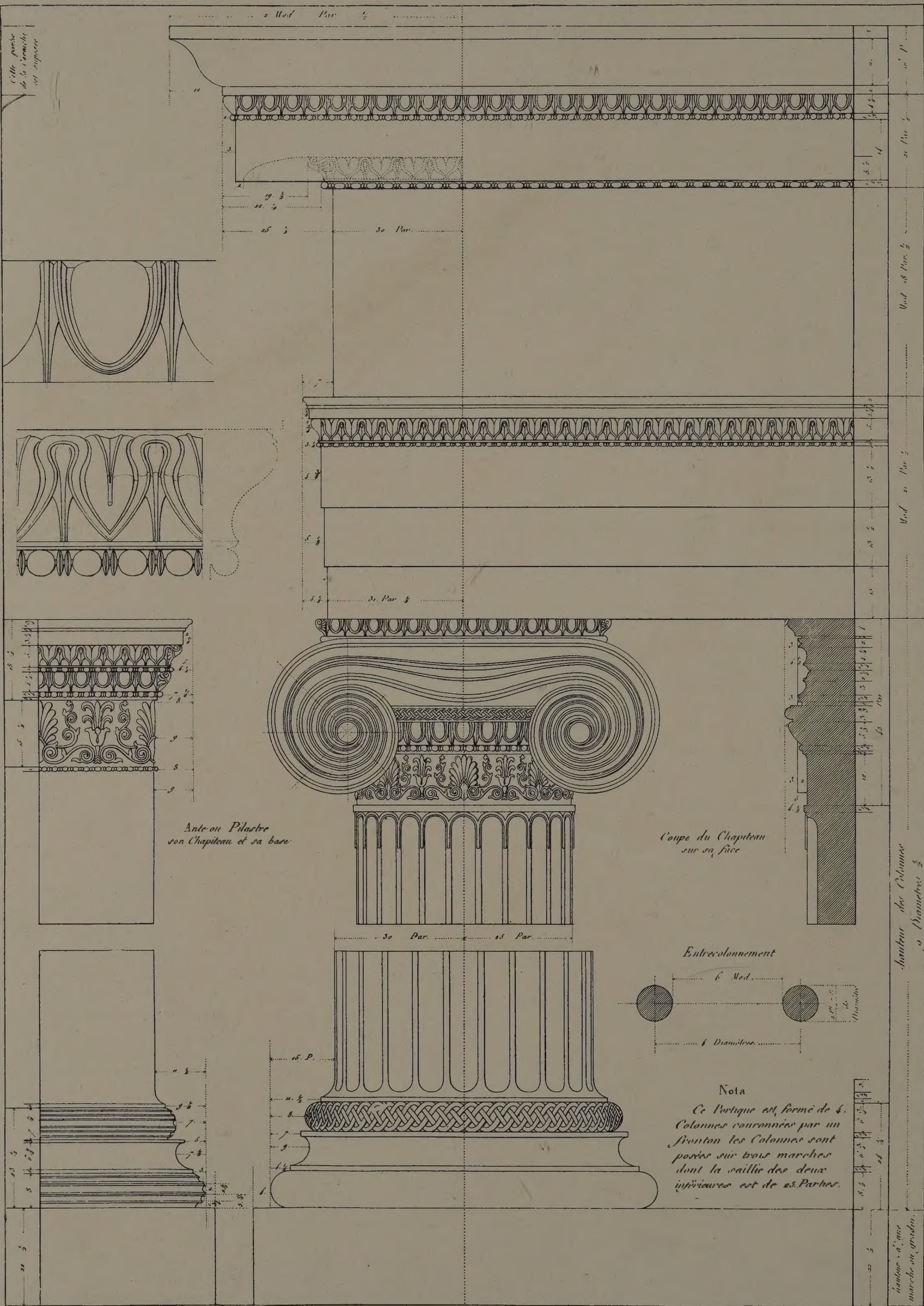
He then proceeds to give explicit and minute directions as to the proportions of a temple, the acoustics of a theatre, and the modular height of a column and its entablature. In its general range of information, his book was not dissimilar from the World Almanac—an Augustinian prototype of Kidder's Handbook—no Roman home was complete without it. And this is the book on which, in default of better authority, the architects of the Renaissance based their dogmatic ideas of Classic proportions. Everything was to be done according to rule, and there was a rule for everything. The module was king; and generally speaking, this idea has been adopted with more or less fervor ever since. If we wish to use an order in these days, it is quite customary to take a copy of the Grand Vignole, and the thing is done.

Personally, I do not think that in the Classic period such things entered into the design of a temple, any more than I think Homer anticipated that some of his lines would be held to express ideas that I feel certain were never intended. Neither his poetry nor any one else's was composed by rule, notwithstanding Mr. Poe's contribution. Πολυφλοίσβοιο θαλάσσης was written without a thought of onomatopoeia, and only because it was a beautiful expression. Similarly, Ictinos developed the subtle proportions of his architecture, not by rule or by module, but by years of study of what had been done, and patient effort to improve on the masterpieces of the past. A module is unquestionably a valuable method by which to express columnar measurements because, being in terms of the lower diameter, or, as some prefer, the mean diameter of the column, it is capable of application in showing proportion without regard to actual linear dimensions. Naturally, a careful investigation into these modular dimensions will develop certain mathematical proportions which can be carried to an almost infinite degree, as may be seen in the remarkable tables published by Mr. Watkiss Lloyd in connection with Penrose's measurements. Speaking of these proportions established for the temple at Priene, Mr. Letheby says, "They are monuments of pure mathematics, their only inaccuracy being in the data on which the calculations are based." In other words, aside from the fact that they are based on measurements which were afterwards proved wrong, they are perfectly good proportions.

In modern times there have been numerous extremely valuable contributions to the literature of Classic Architecture, and roughly, these contributions can be divided into two classes, the first consisting of restorations intended to show, by means of carefully engraved plates or half-tone reproductions of renderings, just how the temples of the immortal gods probably looked. Some of these, as Penrose, are extremely carefully done, and are trustworthy. Others, unfortunately, seem influenced more by the imagination of the restorer and by his anxiety to make a fine rendu, than by actual facts or exhaustive study. In the second class may be included the various histories of architecture and of art, and monographs relating to the latest excavations and discoveries. These publications are many and valuable, and in most cases authoritative, but unfortunately they are not consulted by the modern architect after he has left the class-room, and oftentimes not even in the class-room, while plates of Buhlmann and Normand, and the wonderful restorations in D'Espouy, and the works of our old friend of Vignola, are in most architects'offices, and are continually subject to painful search and unscrupulous and indiscriminate copying.

Personally, I am a most profound admirer of Classic architecture, and I would be the last one to regret the publication of these books, to under-estimate their value, or to criticise their use. What I do criticise and sincerely regret is their indiscriminate and unintelligent use. It is of the greatest possible advantage to us to know what the ancients did, how they used the Orders, and why they did certain things under certain conditions. If we had not this knowledge, we would be under the necessity of attempting to develop new orders of architecture of our own. Gaining nothing from the experience of the past, we would be led into the wildest vagaries, and our architecture would rival the atrocities of cubism and futurism.

But the great trouble with the books that we have is that in few of them is there any indication of why things were done. We either find some elaborate plates showing one man's idea of Classic architecture, or we find a certain rather dry account of excavations and their results, speculations as to the possible antiquity of certain remains, and how they were placed in reference to certain other fragments which have been discovered; but there is no attempt, or scarcely none, to explain the real principles which governed the Greeks and



THE IONIC ORDER OF THE ERECHTHEION.

Romans in the development of their architecture. There seems to be no attempt on the part of the author to try to put himself in the position of the designer of the building and to work out the reasons which probably led him, under certain geographical or climatic conditions, to do certain things. This seems not to have been attempted by any of the restorers who were architects, and is naturally impossible to the archeologist who is not himself an architect. Even though he may have acquired a certain technical knowledge of architecture, he lacks the imaginative qualities which are a necessity to the real architect and designer, and can, therefore, only state his facts and prove his dates; and it often happens that some of his ideas of restoration, although possibly justifiable from an archeological point of view, are ridiculous from the point of view of design. I have always hoped that the fruitfulness of this field would be realized by some experienced architects who had leisure enough to devote themselves to a long and exhaustive study of these problems, and it is with the hope of arousing some interest in this field that this series of articles has been written.

XVI. Engineering for Architects

By DeWitt Clinton Pond, M. A.

Mr. Pond has charge of the practical course in Architectural Engineering at Columbia University. He is the author of "Engineering for Architects" recently published in book form. This series, started in July, 1916 ARCHITECTURE, is a continuation of the previous series concluded in the issue of June, 1915.

IN previous articles the design of steel grillage footings has been discussed and it was pointed out that the beams in these footings had to be checked for bending, shearing and crushing. In about the same manner the monolithic footings under concrete columns must be checked and the processes outlined in the following article are those which are usually employed.

Let it be assumed that the footing, which will be discussed first, is under an interior column, and rests upon soil. The live and dead loads will be assumed to be 500,000 pounds, and 300,000 pounds, respectively. The total load on the footing will be, therefore, 800,000 pounds. To this total must be added the weight of the footing itself in order to find the weight on the soil. It is customary to estimate this weight but for the present problem it will be assumed to be 60,000 pounds, and the total weight upon the soil will be considered as 860,000 pounds.

Section 231 of the New York Building Code gives the presumptive capacities of soil, and it will be noticed by referring to this section that hard dry clay and coarse sand are rated as having the allowable bearing capacity of 4 tons per square foot. The load under consideration being 860,000, and the sustaining capacity of the soil being considered as 4 tons, or 8,000 pounds per square foot, the area over which the footing must be spread will be 107.5 square feet. A footing measuring 10 feet and 4½ inches on a side will cover this area.

In designing a concrete footing, it is usual first to determine the stresses in the steel and concrete due to bending. To do this the upward pressure of the soil must be determined and as the weight of the footing itself will cause no tendency toward bending in the footing the load that is brought by the column is the only one considered. It will be remembered that this load was given as 800,000 pounds. The area of the footing is 107.5 square feet, and the load per square foot that will press up against the footing, to cause bending, will be 800,000 ÷ 107.5 = 7,430 pounds.

A plan and elevation of the foundation is shown in Fig. 92, and it will be noticed that the plan can be divided into four parts by drawing two diagonals. As the plan is square these parts will be equal. In finding the bending moment in the footing the upward pressure under each of the fourths is considered.

A column bearing 800,000 pounds and reinforced with vertical and spiral reinforcing, will be 31 inches, or 2 feet and 7 inches in diameter, as determined in the last article, and as shown in plan in Fig. 92. In Fig. 93 it will be noticed that the position occupied by the circular column (Fig. 92) is now occupied by a square having a side measuring 1 foot, 10 inches. This square is known as the "equivalent square" and the side is made equal to seven-tenths of the diameter of the circle. The diameter of the circular column being 2 feet, 7 inches, the equivalent square will have a side of 2.5833 × .70 = 1.81 feet, or 1 foot, 10 inches as shown.

The fourth of the footing, considered as having a tendency to bend upward around the equivalent square, is in reality a trapezoid, having a base equal to 10 feet, 4½ inches, a side parallel to the base 1 foot and 10 inches long, and an altitude equal to one-half of the difference between 10 feet, 4½ inches and 1 foot, 10 inches, or equal to 4 feet, 3¼ inches.

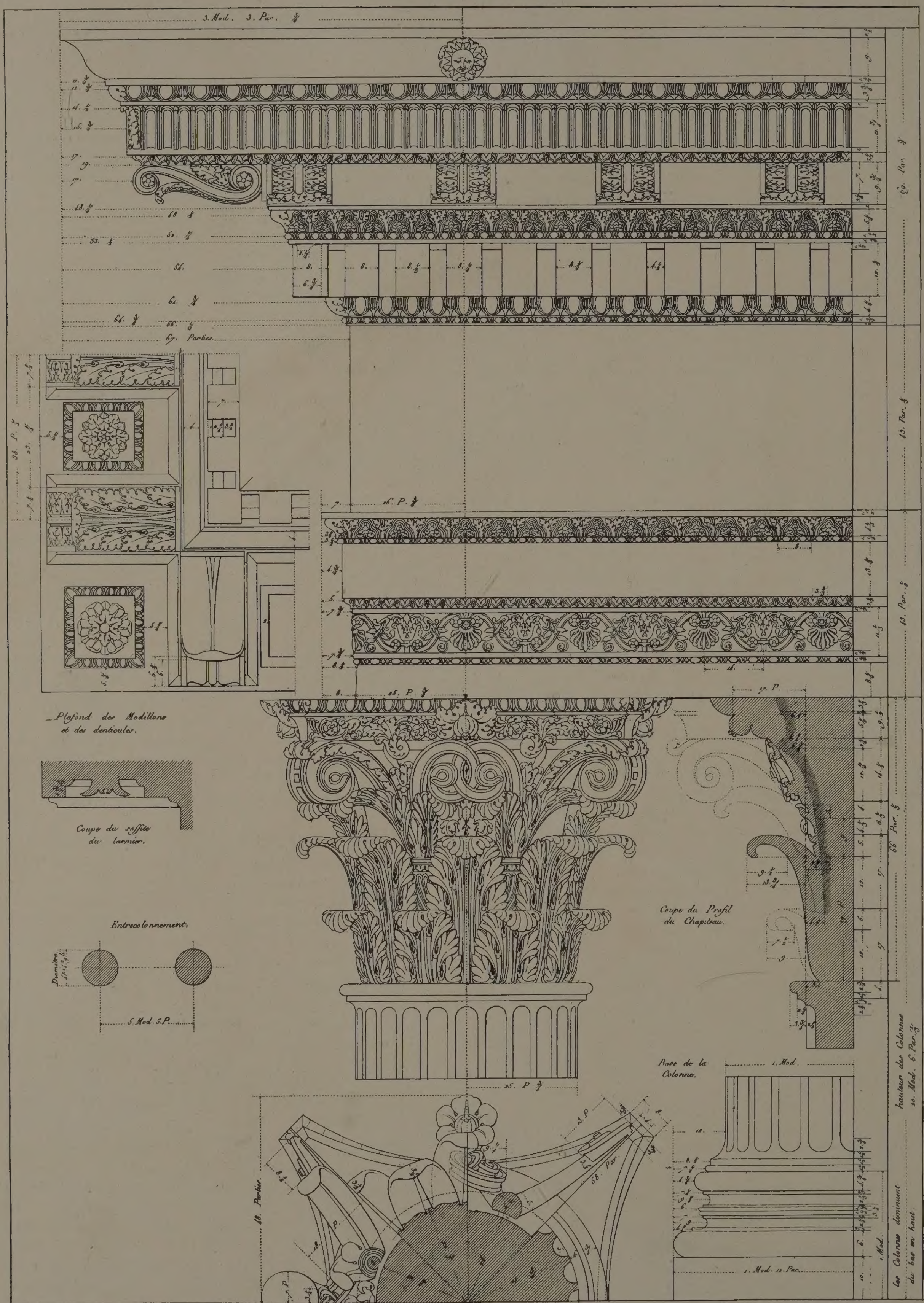
Referring to Fig. 93, it can be seen that the trapezoid is sub-divided into two triangles and a rectangle. The rectangle measures 4.27 feet by 1.81 and has an area of 7.73 square feet. The two triangles will have a combined area equal to the area of a square, the sides of which are 4.27 feet long. This area will equal 4.27 × 4.27 = 18.23 square feet. The pressure per square foot will be 7,430 pounds and so the pressure on the rectangle will be 7.73 × 7,430 = 57,400 pounds, and the pressure on the two triangles will be 18.23 × 7,430 = 135,400 pounds.

The next consideration is the moment caused by the two triangles and the rectangle. The moment due to the rectangle will equal the pressure—57,400 pounds—multiplied by the distance from the centre of the rectangle to the edge of the equivalent square, or 4.27 ÷ 2 = 2.14 feet. This moment will equal 57,400 × 2.14 = 122,836 foot pounds, or 122,836 × 12 = 1,474,000 inch pounds.

The moment due to the two triangles will equal the pressure—135,400 pounds—multiplied by the distance from the apex to the centre of gravity of each triangle. This distance is equal to two-thirds of the altitude, which equals 2/3 × 4.27 = 2.84 feet, or 34.16 inches. This moment will equal 135,400 × 34.16 = 4,625,300 inch pounds, and the total moment will be the sum of these two. 1,474,000 + 4,625,300 = 6,099,300 inch pounds.

In finding the depth the whole footing is considered as a beam, having a length of 10 feet and 4½ inches and a breadth equal to the diameter of the column in inches plus six inches. The reason for making this the width of the beam may be made clear by referring to Fig. 92. The elevation of the footing shows that there is a flat horizontal surface at the top, upon which the column rests, and this surface extends 3 inches on either side of the column. This makes the total

(Continued page 213)



THE CORINTHIAN ORDER OF THE TEMPLE OF JUPITER STATOR.

(*Continued from page 211*)

width of this surface equal to 31 inches plus 6 inches, or 37 inches.

In Article XIII, in the July issue of ARCHITECTURE, the depth of slabs was considered. The slabs were regarded as being 12 inches wide and, if the depth of the footing is to be determined on the basis as outlined in the above article, it will be necessary to divide the bending moment by the width of the slab. 6,099,300 ÷ 3.08 = 1,980,000 foot pounds which is the moment for each foot of width of the beam under consideration.

In Article XIII the statement was made that the stress in the steel—S—will equal 1,462.5 d. It was also stated that the moment—M—will equal S × ⅞ d. d. in the above cases is used to denote the depth from the top of the beam—or footing—to the centre of the steel, and these figures only will be considered in connection with beams or slabs 12 inches wide.

By combining the two statements the following results will be obtained:

$$S = 1{,}462.5\ d.$$
$$M = S \times \tfrac{7}{8}\ d.$$
$$M = 1{,}462.5 \times d. \times \tfrac{7}{8}\ d.$$
$$d^2 = (M \times 8/7) \div 1{,}462.5.$$
$$d^2 = 1{,}980{,}000 \times 8 \div 1{,}462.5 \times 7 = 1{,}547.$$
$$d = 39.3.$$

If d is considered as 39½ inches and if it is necessary to add 4½ inches of concrete below the steel the total depth of the footing will be 44 inches.

A formula that will give the depth of the footing, and which is based on the calculations given above, is

$$d^2 = \frac{9.38 \times M \text{ (in thousands of inch pounds)}}{\text{Diam. of Col. in inches} + 6.}$$

Substituting in the formula the figure 6,099 for M, and the value 31 for the diameter of the column, the result is

$$d^2 = \frac{9.38 \times 6{,}099}{31 + 6}$$

By solving the above formula the result will be that the effective depth is determined as 39.3, as shown above.

The soil being rated as having a bearing capacity of 4 tons per square foot, the area of the footing will be comparatively small and as a result there will be little bending in the footing as compared with the shearing effect of the column. This shearing is regarded as "punching shear" and the column may be regarded as having the effect of punching a hole directly through the footing, the hole having a diameter equal to that of the column. The total pressure causing this shear will be equal to the pressure exerted upon the under side of the footing exclusive of that area directly under the column, and equal to the cross sectional area of the column. As has been stated the area of the footing is 107.5 square feet. The area of the column is 5.2 square feet. The net area of the under side of the footing will be 107.5 — 5.2 = 102.3 square feet. The total shear will equal 102.3 × 7,430 = 760,100 pounds.

The circumference of the hole that may be punched out of the footing is equal to that of the column. The diameter of the column is 31 inches. 31 × 3.1416 = 97.4 inches. This multiplied by seven-eighths of the depth, and by the shearing value of concrete per square inch should equal the shear found above. As the depth of the footing may be varried to suit the design, this d will be left as the unknown in the following equation, in which 150 pounds per square inch is the shear.

$$97.4 \times \tfrac{7}{8}\ d \times 150 = 760{,}100.$$
$$\text{So } d = 760{,}100 \div (150 \times \tfrac{7}{8} \times 97.4).$$
$$d = 59.6.$$

To this depth must be added 4½ inches to obtain the total depth which will be 5 feet and 4 inches. It will be seen that this is considerably greater than the depth found above for bending, but this must be used as otherwise the footing will fail by shearing.

The depth being determined, the next thing to be investigated will be the amount of steel that will be necessary for reinforcing against bending. The moment was found to be 6,099,300 inch pounds. As has been stated, the stress in the steel—S—multiplied by ⅞ d will give the moment, or, to reverse the reasoning, the stress in the steel will be equal to eight-sevenths of the moment divided by the depth.

$$S = \frac{6{,}099{,}300 \times 8}{59.6 \times 7} = 117{,}000 \text{ pounds.}$$

Dividing 117,000 pounds by 16,000 pounds—the allowable stress per square inch for steel—the result will be the

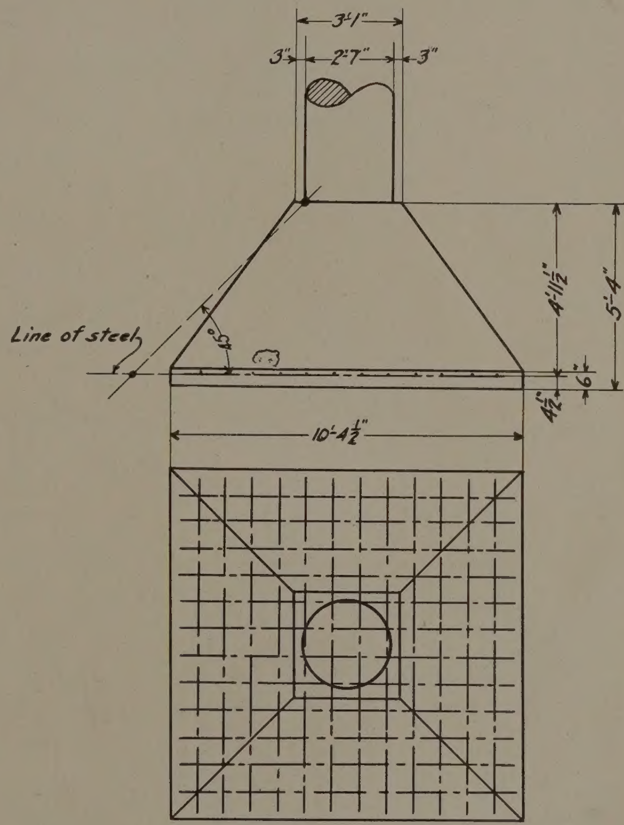


FIGURE 92

number of square inches of steel required. 117,000 ÷ 16,000 = 7.31 square inches of steel. This can be made up by using thirteen ¾-inch square bars.

Another item to be investigated in connection with reinforced concrete footings is the diagonal tension, but, as this is shown better when the footing rests upon soil having a bearing capacity of only 2 tons per square foot, this will be taken up later.

It often happens that the soil under foundations or footings is of the character of wet sand or firm clay on which the allowable pressure per square foot is only two tons. If this had been the case when the footing designed above was under consideration the area of soil over which the footing would have had to spread would have been 860,000 ÷ 4,000 = 215 square feet. The footing should have measured 14.66 feet

on a side, and the upward pressure per square foot that would have caused bending would have been 3,720 pounds.

By referring to Fig. 94 it will be seen that the equivalent square measures 1 foot and 10 inches on a side, as before, but that the outside dimensions of the footing are 14 feet and 8 inches by 14 feet and 8 inches. The rectangle will measure 1 foot and 10 inches by 6 feet and 5 inches. The bending moment will be determined as follows:

$$
\begin{array}{lr}
6.41 \times 1.83 \times 3{,}720 \times 38.5 = & 1{,}677{,}000 \\
(6.41 \times 6.41 \times 3{,}720) \times (2/3 \times 77.0) = & 7{,}850{,}000 \\
\hline
\text{Total} = & 9{,}527{,}000
\end{array}
$$

If the discussion given above for the first footing is remembered, all the figures can be verified. From these calculations it can be seen that the bending moment for the new condition will be considerably larger than for a footing on 4-ton soil. In order to find the depth required for this footing the following formula will be made use of and the proper substitutions made.

$$d^2 = \frac{9.38 \times \text{M (in thousands of inch pounds)}}{\text{Diam. of col. in inches} + 6}$$

$$d^2 = \frac{9.38 \times 9{,}527}{37}$$

$$d = 49.1 \text{ inches.}$$

The total depth of this footing as far as bending is concerned may be 54 inches, but this must be checked for shear.

The total area of this footing is 215 square feet. The area of the column is 5.2 square feet, and the net area of the footing will be 215 — 5.2 = 209.8 square feet. If the upward pressure of the soil is 3,720 pounds per square foot, the shearing pressure will be 209.8 × 3,720 = 780,500 pounds.

The circumference of the column will be the same as before and so the formula for the punching shear will be

$$97.4 \times \tfrac{7}{8}\, d \times 150 = 780{,}500.$$

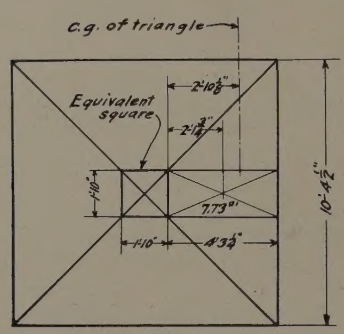
$$d = 61.3.$$

By adding 4½ inches to this the total depth of 5 feet and 6 inches is obtained. It will be noticed that the depth in this case as before was governed by the shear and not by the bending in the footing. To determine the amount of steel needed the formula $M = \tfrac{7}{8}\, d \times S$ will be used. M equals 9,527,000 inch pounds, and d has been found to be 61.3 inches, so the formula becomes

$$S = \frac{9{,}527{,}000 \times 8}{61.3 \times 7} = 177{,}600 \text{ pounds.}$$

$$177{,}600 \div 16{,}000 = 11.1 \text{ square inches.}$$

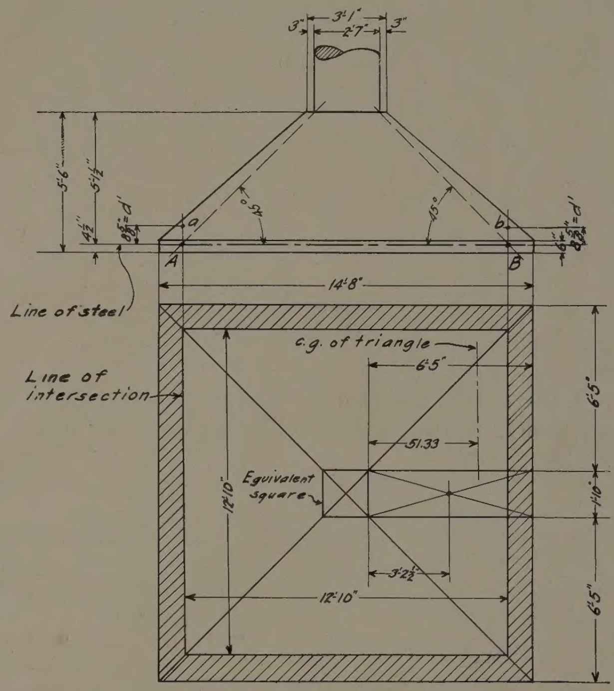
This area of 11.1 square inches must be supplied by the steel bars, and twenty ¾-inch square bars will be large enough.



FIGVRE 93

The next thing to be investigated is the diagonal tension set up in the footing. In Fig. 94 it will be noticed that a line is drawn at an angle of 45 degrees with the horizontal and through a point located at the intersection of the outside of the column with the horizontal surface at the top of the footing. Such a line, drawn in Fig. 92, would have fallen outside of the footing at the point where it intersected the line of the reinforcing steel. In this figure the point of intersection is within the footing and in this case the diagonal tension must be investigated. At this point there must be enough thickness of concrete above steel to withstand a shear of 40 pounds per square inch, or otherwise stirrups must be provided.

The diameter of the column is 31 inches, and the distance from the horizontal surface at the top of the footing to the steel is 5 feet 1½ inches. The distance between A and B (Fig. 94) will therefore be 31 inches + 61.5 inches + 61.5 inches = 154 inches or 12 feet and 10 inches. The length of



FIGVRE 94

the side of the footing is 14 feet and 8 inches, and the overhang of the base beyond A or B is 11 inches.

The area of the base is 215 square feet, and the area included within the intersections is found by squaring 12.83 feet, which gives an area of 165 square feet. The area outside of the lines of intersection will be 215 — 165 = 50 square feet. The upward pressure due to the soil is 3,720 pounds per square foot, and if this is applied over 50 square feet the total pressure causing diagonal tension will be 3,720 × 50 = 186,000 pounds.

The entire length around the line of intersection will be 4 × 12.83 feet or 51.33 feet, and if this is multiplied by 12 the number of inches will be determined. 51.33 × 12 = 616 inches. This multiplied by $\tfrac{7}{8}\, d'$ and by 40 pounds allowable shear should equal or be more than 186,000 pounds. Or d', the depth at the point of intersection, should equal 186,000 ÷ (616 × ⅞ × 40) = 8.62 inches.

If at either point A or B a line is drawn vertically upward measuring 8⅝ inches, the upper end of this line establishes the point through which the upper surface of the footing must pass. If the distance is less than this the difference between the actual shear and the allowable shear on this particular section should be determined and the discrepancy taken care of by means of stirrups. However, it is seldom that use is made of stirrups in the design of footings.

It will be remembered that the weight of the footing was assumed and this should be checked in order to be sure that the design of the footing is correct. In order to determine the

weight of the footing the actual shape of it must be found. The horizontal surface, upon which the column rests, is three inches larger on each side than the column, making the width of the surface 37 inches, as has been stated. The under surface of the footing is 14 feet, 8 inches square, and around the outside there must be a vertical surface which must not be less than six inches high. If, however, the points *a* or *b* should come at such height that they would fall outside of the base if the sloping surface should be brought to this six-inch height, then this vertical surface must be made higher, to give the proper thickness of concrete above the steel. In the present case the six-inch height governs the slope, as can be seen in Fig. 95.

The footing is made up of a prism of concrete, with a base 14.6 feet square, and a height of one-half a foot, and on this rests a truncated pyramid, with a base equal to that of the prism, an upper surface of $3.083 \times 3.083 = 9.5$ square inches, and a height of five feet.

The volume of the prism will equal $215 \times \frac{1}{2} = 107.5$ cubic feet. The volume of the truncated pyramid will be given by using the formula $V = \frac{d}{6}(A_1 + A_2 + 4A_3)$, in which A_1 is the area of the top surface, A_2 is the area of the bottom surface, and A_3 is the area of an intermediate surface half way between the top and bottom. Substituting in this formula, and finding that the side of the intermediate surface is $(14.66 + 3.08) \div 2 = 8.87$ feet, the result is $V = 5/6\ (9.5 + 215 + 4 \times 8.87 \times 8.87) = 450$ cubic feet.

The volume of the entire footing will be $107.5 + 450 = 557.5$ cubic feet, and as each cubic foot weighs 144 pounds, the weight of the footing will be $557.5 \times 144 = 80{,}000$ pounds approximately.

The assumed weight was considered as 60,000 pounds, so for careful checking the calculations might be gone over again, but it will be found that there will be but little difference in the design.

"The Box"—The Country Home of Harvey S. Ladew

Brookville, L. I.

James W. O'Connor, Architect

ABOUT a mile distant from the Piping Rock Club is the country home of Harvey S. Ladew at Brookville. With the characteristic individuality of a bachelor and sportsman, Mr. Ladew has created most attractive and livable quarters, remodelled from the old farmhouse which, with the blacksmith shop, stood in the midst of this fertile country now traversed and retraversed by the Meadow Brook hounds, of which Mr. Ladew is an enthusiastic follower.

The drive to the house is quaint, leading one over the brook from which the village takes its name, through the shaded lawn and on past the studio and stables which are grouped near the house, as Mr. Ladew wished to see his hunters from the sleeping porch. The stables combine every comfort and luxury for the horses, with commodious box stalls, feed and rack room; the fence, as shown in the illustration, making the fourth side of the enclosure. The old-fashioned appearance of the stable group is strengthened by butts, white with black hoops which catch the rain water as in olden times.

In the studio, the outlines of the original smithy have been preserved, with the addition of a spacious fireplace, a large studio window and a series of casement windows overlooking the road. Finished with rough plaster and furnished in old oak, this room is decidedly inviting. Through the windows one may see the old-fashioned perennials bordering the little path to the passage connecting the studio with the other buildings.

The garage, not having the almost human interest the occupants of the stables possess, is situated farther from the house and is sufficiently large to accommodate five or six cars with sleeping quarters above for the men. The kennels, where Mr. Ladew raises Dandydinmotts and wire-haired fox terriers, consists of a central pavilion or trophy room and two wings which accommodate the dogs.

Part of the original farmhouse is preserved in the entrance hall, with the living room opening on the left—striking, because of its casement windows with their small leaded panes, these, in fact, being used throughout the building, with here and there a broken pane, in deference to conditions usually found in an old house. The old sporting pictures, hung attractively, the fireplace, the many books make this room one of rare charm. French windows lead out to the terrace where, against the garden wall on two sides, are fruit trees trained in various shapes.

The dining room, on the right, has an oak wainscot above which are the plaster walls. The doors are flush with segmental heads and have old strap hinges. The floor is laid with eight-inch boards with wide joints. There are in this room a fine old refectory table and Dutch dresser in entire harmony with their surroundings. Opening at one side is the breakfast alcove having casement doors so arranged that three sides can be opened, practically converting it into a porch.

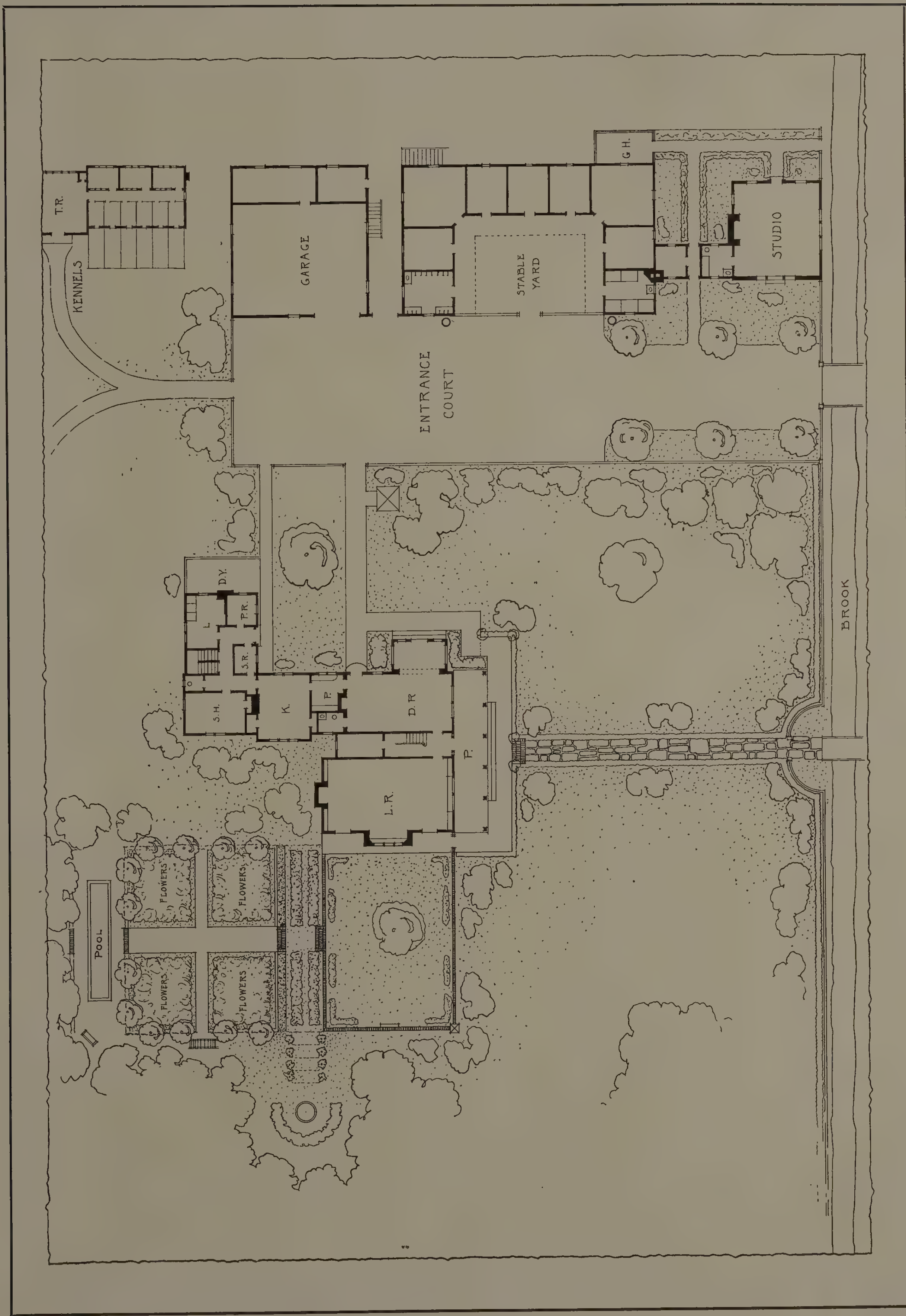
On the second floor, the guest rooms are furnished in typical farmhouse style. The chintz used in one of the bedrooms is a rare old English one, a sample of it being in the Metropolitan Museum. All have deep casement windows and attached to each is a thoroughly luxurious bathroom. Very unusual and distinctive is Mr. Ladew's own bedroom, being half timbered and possessing a corner fireplace with hearth raised above the floor level. The doors are flush with strap hinges. A unique feature is that the entire oak trim has been adzed. Reverting to the early days, wooden pegs were used in laying the wide boards of the floor. A door from this bedroom naturally leads to the sleeping porch as shown in the illustration.

The garden is a joy. Even to those who are uninterested in the actual cultivation of flowers and take pleasure only in the result, the vista from the brick walled terrace, through the entire chain of gardens, is wonderfully charming. Surely among so many varieties of perenniels, one could find a valued favorite and with its faint fragrance bring back memories long out of mind. The goldfish pool, the water lily pool, the roses, the lilacs, the apple trees and almost countless other varieties of plants and flowers make this garden invitingly cool and restful and a delight to the eye.

The whole group has been designed in conformity with the exterior appearance of an old Long Island farm. All the buildings are covered with hand-split shingles and, nestling on the hillside among the beautiful old trees, the place has a charm all its own.

"THE BOX," ESTATE OF HARVEY S. LADEW, BROOKVILLE, L. I.

J. W. O'Connor, Architect.

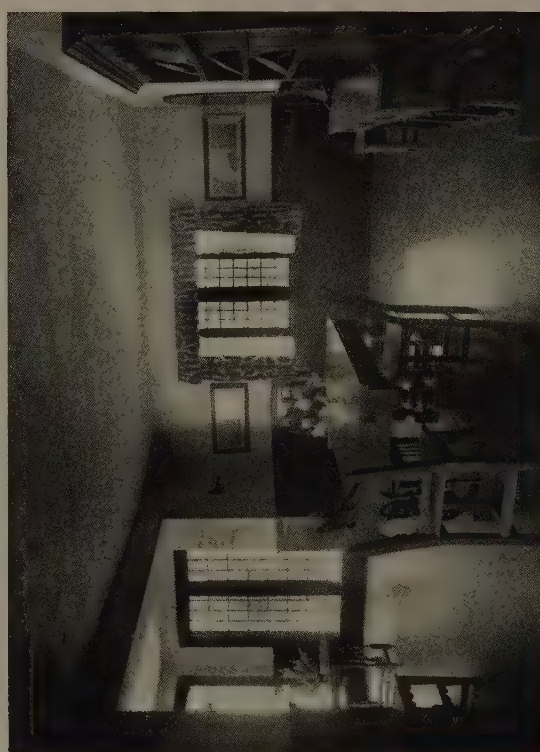


PLAN, ESTATE OF HARVEY S. LADEW, BROOKVILLE, L. I.

J. W. O'Connor, Architect.


Living Room.

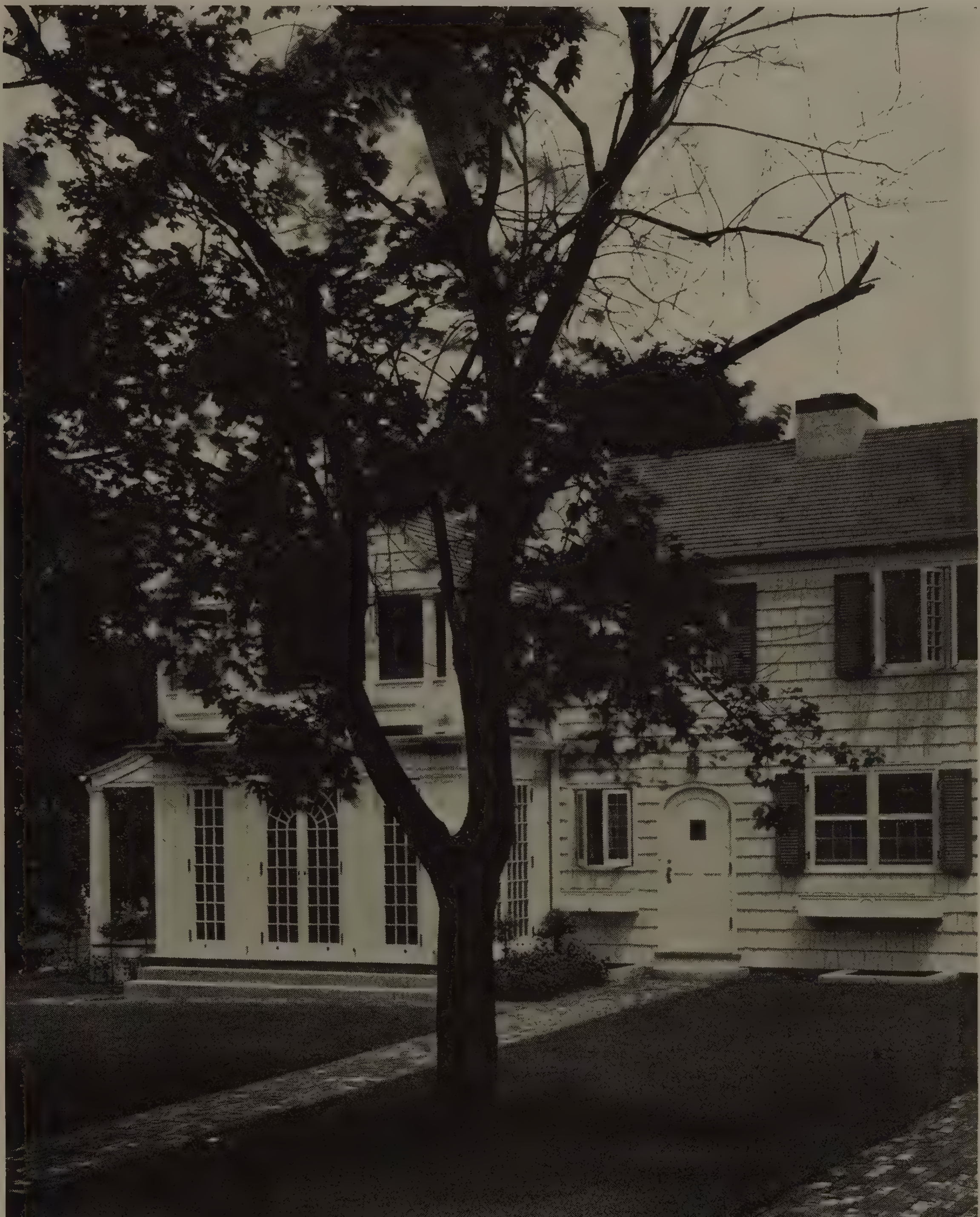

Corner, Owner's Bedroom.


Dining Room.


Dining Room.

INTERIORS, "THE BOX," ESTATE OF HARVEY S. LADEW, BROOKVILLE, L. I.

J. W. O'Connor, Architect.



DETAIL, "THE BOX," ESTATE OF HARVEY S. LADEW, BROOKVILLE, L. I. J. W. O'Connor, Architect.

Studio from the North.

Stables.

ESTATE OF HARVEY S. LADEW, BROOKVILLE, L. I.

J. W. O'Connor, Architect.

STUDIO, SOUTH FRONT, ESTATE OF HARVEY S. LADEW, BROOKVILLE, L. I. J. W. O'Connor, Architect.

GARDENS, ESTATE OF HARVEY S. LADEW, BROOKVILLE, L. I.

J. W. O'Connor, Architect.

Deshong Memorial Gallery, Chester, Pa.

Clarence W. Brazer and E. Donald Robo, Architects

THE late Alfred O. Deshong spent most of the latter years of his life in making a collection of modern paintings and fine Chinese bronzes and ivories. Many of the paintings have been exhibited at the Salon in Paris and at the various international expositions in this country. Upon his death in 1913, he left his estate and mansion with its art collection to the city, in charge of three trustees, and willed that a suitable building be erected for the housing of his works of art and that the estate of some twenty-seven acres, which is situated in the center of the city of Chester Pa., be made into a public park.

The beautiful marble structure and the surrounding park are the results of two competitions, both of which were awarded to Mr. Brazer and Mr. Robb as associated architects.

The treatment of the grounds includes various features, such as swimming pools, outdoor gymnasiums, etc. In connection with the building, shown in this issue of ARCHITECTURE, the completion of the entire scheme will give a most imposing and beautiful institution on the banks of the Chester river.

The modeling and carving of the marble and the models for the bronze are by Donnelly & Ricci. Into the carving there has been introduced many forms of the ivories and fine bronzes to be found within the galleries. The bronze doors and window grilles have been treated in a patina to match the antique Oriental dogs and lanterns placed about the exterior of the building. The building is provided with an indirect heating and ventilating system controlled by thermostats and humidistats to supply a uniform amount of moisture under varying weather conditions. The mechanical plant is in a small basement under the rear with entrance from the exterior of the building only.

The building is of fireproof construction and was erected by the firm of Frank N. Goble.

The main gallery floor is supported directly upon earth while cemented pipe-trenches encircle this room under the surrounding galleries which have floors of reinforced concrete construction covered with cork tile. Each gallery is cut off from the adjoining galleries by automatic sliding copper covered fire-doors.

The large main gallery for paintings has been modeled after the dimensions of the Emperor of Germany's famous gallery at Cassel with very successful results as to the lighting effect during the daytime, as all of the galleries are practically free from raking sunlight at all seasons of the year. The artificial lighting is by reflectors above the diffusing sash.

As the collection is now complete, the paintings have been hung directly from plugs in the masonry walls to exclude the usual non-fireproof sheathing. The walls are hung with a gray "monk's" or "friar's" cloth which gives a very delightful background for the paintings and for the rugs which are hung above the paintings on the walls of the large central gallery.

The installation of the art collection has been under the direction of Mr. John A. Getz who also prepared the catalogue.

Legal Decisions of Interest to the Architect

These decisions appear monthly and are edited by Mr. John Simpson, the well-known lawyer.

ARCHITECT'S DECISION AS TO EXTRA WORK.

In proceedings commenced in the Court of Claims to recover from the United States for extra work performed in the construction of the foundation for the extension and remodeling of the United States assay office in New York, the Supreme Court of the United States holds that any ambiguity in the specifications arising from the use of the singular word "building" instead of the plural word "buildings" in specifying the underpinning required to protect adjoining property, in the face of the contractor's knowledge, by inspection of the material conditions, and of the other parts of the specifications, which *inter alia,* call for "rear walls" instead of a "rear wall," could, at the utmost, only give ground for dispute, and the extra cost of underpinning the rear walls of both buildings must be borne by the contractor, where the supervising architect decides that the contract calls for such underpinning, and the contract makes final his decision as to the proper interpretation of the drawings and specifications.—Merrill-Ruckgaber Co., *vs.* United States, 36 U. S. Sup. Ct., Rep. 662.

"EMPLOYEE" OR "INDEPENDENT CONTRACTOR?"

A carpenter and builder contracted with the owner of a macaroni factory to raise the second and third story floor and roof. Additional work developed during the performance of the contract, for which the contractor presented itemized bills for labor and materials to the owner. An item of this was placing a partition. While working upon the partition, the contractor was killed by the collapse of the building. Proceedings for compensation were brought under the New York Workmen's Compensation Law, it being claimed that the contractor was employed by the owner in a hazardous employment within the meaning of the Act. The company came within group 33: "Canning or preparation of fruit, vegetables, fish or foodstuffs; pickle factories and sugar refineries." The State industrial commission awarded compensation. On appeal the Appellate Division reversed their award (170 App. Div. 103, N. Y. Supp. 1076). The commission appeals. The New York Court of Appeals has now sustained the order, holding that the deceased was not an employee, because he was not engaged in the preparation of macaroni. The placing of the partition was a specific act, for which the deceased was specially employed, which had no relation to the hazardous employment, except that it made more useful, within the contemplation of the employee, the building in which the employment was carried on. Part of the language creating group 42 was also invoked: "Construction, repair and demolition of buildings." This was held to be answered by the fact that the company did not carry on the occupation of constructing, repairing, and demolishing buildings for pecuniary gain.

Mr. Justice Seabury dissented, on the opinion of Mr. Justice Woodward in the Appellate Division. The latter said, in part: "He was doing the work personally; he had then no assistants, and had not had any on the work on which he

was then engaged. There had been no contract, written or oral, between himself and his employer regarding the work he was then doing or payment therefor, except that he was told what the employer wanted him to do and he was doing it. He was to be paid by the hour for his time with reimbursement for any materials furnished by him. . . . He had no office or store, no bill heads or contract forms, no regular employees, no pay roll, and no insurance as an employer. His work was invariably of the artisan's grade; for at least 14 years he had worked continuously as a carpenter, usually alone on individual jobs, and usually by the day or hour. It does not appear that he ever exercised anything approximating supenintendence or independent direction of work he was hired to do."—Barger *vs.* Massaro Macaroni Co., 113 N. E. 406.

Penalties for Delay.

In a suit to foreclose a contractor's mortgage on the building built by him, the owner claimed a penalty, provided by the contract, of $25 a day for delay by the contractor in completing. The Michigan Supreme Court disallowed the claim, because the delay was due to changes and delay by the owner. —Malcolmson-Houghton Co. *vs.* Gregorian Building Co., 158 N. W. 126.

Construction of Building Restrictions.

While, in determining the intention of parties to a deed to create a building restriction, the deed is to be construed favorably to one against whom it would be enforced, the Minnesota Supreme Court holds that a mere doubt as to the extent of a restriction does not prevent its enforcément, but it must be construed fairly according to the intention of the parties.—Godley *vs.* Weisman, 158 N. W. 333.

Recovery from Surety for Contractor's Delay.

The Minnesota Supreme Court holds that a surety upon a contractor's bond is not released from liability by the obligee's acquiescence in the contractor's default when, with knowledge of that default, the surety encourages a waiver thereof by the obligee. For a delay in performance which constitutes a breach of the contract, the obligee is entitled to recover of the surety such damages as naturally resulted from the delay, and such as might be recovered against the principal. —McLeod *vs.* National Surety Co., 158 N. W. 619.

Excuse for Breach of Excavation Contract—Liability on Surety Bond.

In an action by a general contractor against subcontractors for breach of contract it appeared that the plaintiff and defendants entered into a contract in which the defendants agreed to excavate sufficient sand for the building of the foundation of a large hotel at Atlantic City at an agreed price per foot. After removing several thousand yards of sand, the defendants abandoned the work. They defended the action upon the ground that, as the plaintiff required, and they had performed, work in addition to that called for by the contract, without the plaintiff's producing a written order as required by the contract if any alteration was made in the work, the plaintiff had thereby abrogated the contract, and justified their refusal to further perform. It appeared that the additional sand excavated amounted to only 28 cubic yards. The Court of Errors and Appeals of New Jersey held that this additional work was not an alteration within the meaning of the contract, and that the absence of the order was not a good defense.

It was also held that the penalty named in a surety bond is the extent of the obligor's liability in an action on such bond; but the giving of a bond to indemnify a party against loss arising from nonperformance of a contract does not, in an action on the contract for its nonperformance, limit the recovery in that action to the penalty in the bond. The bond indemnifies to the extent of its penalty, but is no limitation of the amount to be recovered in a separate action for breach of the original contract.—Cramp & Co. *vs.* Doughty, 98 Atl. 260.

Payments to Contractor.

A building contract contemplated alterations, and provided, in relation to the price, that it should be "$12,000, subject to additions and deductions as hereinbefore provided," to be paid to the contractor upon certificates of the architect "as follows: eighty-five per cent. of all work completed and all materials on the ground to be computed in value on or about the first of each month and payment made for the same." The owner, though not paying more than 85 per cent. of the completed work and materials, did pay more than 85 per cent. of the $12,000. In an action on the contractor's surety bond the Iowa Supreme Court holds that 85 per cent. applied to the "work completed and all material on the ground," and was not limited to the $12,000 allowance; the owner having the right to hold back from the contractor a sum equal to 15 per cent. of the work completed and materials on the ground. —Hileman & Ginett *vs.* Faus, 158 N. W. 597.

Action on Surety Bond—Payments to Contractor.

In an action on a contractor's surety bond the defendant claimed that the plaintiff postponed payments and by so doing released it. The contract provided that payments should be made in current funds. Some payments were made by notes. The surety claimed that this amounted to a postponement of payments and so discharged its obligation. This contention was not sustained. Prejudice was not shown and without prejudice the surety would not be released.

The surety also claimed that it was released because payments were made without the architect's certificate and without a final certificate. This contention was not sustained. The payments were made as the work progressed. Certificates were made by the architect. The final payment was made on an itemized bill approved by the architect. That was the only payment without a certificate. The absence of a certificate, the payment being one proper to be made and being approved by the architect, did not release the surety.—Trustees *vs.* United States Fidelity, etc. Co., Minnesota Supreme Court, 158 N. W. 709.

Priority of Liens.

A mortgage upon real estate was given before the construction of any building thereon. Construction of a building was commenced before money was paid out by the mortgage, but the whole amount of the mortgage was later paid out in payment of bills for the construction. The Minnesota Supreme Court holds that the mortgage has priority over mechanics' liens which attach after the mortgage is given, but before the money is paid out. Under the Minnesota mechanics' lien law, where a building is erected, all liens attach at the time the first item of material or labor is furnished for the beginning of the improvement, and this is true though the architect prepared plans some time earlier. The Court distinguished the decision in Lamoreaux *vs.* Andersch, 128 Minn., 261 where it was held that an architect might have a lien, as against the interest of the owner of the property who employed him, for the value or price of his services in preparing plans, though the owner abandoned the improvement before anything was done on the ground. But it was not held in that case that where a building is actually constructed, liens attach as against the owner of the land, as of the time the architect commences the preparation of his plans. The statute does not admit of such a construction.—Erickson *vs.* Ireland, 158 N. W. 918.

ARCHITECTVRE

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PLATES AND ILLUSTRATIONS

Editorial

The American Institute of Architects and its Honor Code—Co-operation of the Architect and Draughtsman

Editor ARCHITECTURE.
Dear Sir:

I noticed your editorial in the September issue in reference to the honor of the American Institute of Architects and quite agree with you that the Institute is perfectly capable of protecting its honor. I will be interested to see the further development of this case. Yours truly,

New York. J. H. DINSMORE.

Far be it from us to interfere in the workings of the Institute for which we have the greatest respect. We have no desire to advise them in any procedure on any subject they may wish to take. The editorial referred to was written on account of the numerous questions raised not only by the profession but also by laymen.—EDITOR.

Editor ARCHITECTURE.
Dear Sir:

The thanks of all architectural draughtsmen are due to you for giving publicity to the letter from one of our number touching on a subject of interest, both to architects and their assistants, and I feel sure some good will result should you keep your columns open for further discussion on the subject.

Architectural draughtsmen may be divided into three classes. All offices are more or less familiar with the draughtsman who, without sufficient education to start with and without the energy or ability to acquire it later, may be classed as a mechanic who never rises above that level and who would certainly be better off in some other walk of life. He finds himself out of his element in associating with men of higher attainments and obliged to keep up a decent appearance on a small and uncertain salary. We can feel sorry for him for he doubtless drifted into architecture without knowing that there is anything more in it than in cutting hair or laying bricks, but we cannot help him.

At the opposite end is the man, quoted in your comments, of exceptional ability who has risen to prominence from obscurity. But the citing of such cases cannot do away with the fact that there remains the third class, the great majority, men of average education and ability who find themselves unable

Continued page 227)

House, Mrs. Arthur Scott Burden, Jericho, R. I.

House, Ogden L. Mills, Woodbury. L. I.

House, George H. Myers, Washington, D. C.

House, James S. Frick, Guilford, Baltimore, Md.

MONTHLY PICTORIAL REVIEW SHOWING THE BEST WORK PRESENTED BY OUR CONTEMPORARIES.

The work of John Russell Pope, Architect.

The Brickbuilder.

(Continued from page 225)

to earn more than a building mechanic, or at best a foreman, and with no more certainty of continuous employment.

Take, for instance, the case of an ordinary clerk: he can hope with diligence to rise to a position in some corporation where, even though he may not earn much, he will at least have a certain position and can be happy in his little home with its cheap furniture and inartistic surroundings, which would be gall and wormwood to the draughtsman who, with his more cultivated taste for better things, is obliged to exist under like conditions, but our profession is so uncertain that a draughtsman is always worried with the haunting fear of that dread call to the chief's sanctum, when he will receive the intimation that work is falling off, etc., etc., and that he had better look out for another job, and then begins the wearisome, humiliating, heart-breaking hunt from office to office for a new position.

So much for our troubles, now for the cause and remedy.

Does not the root of the trouble lie in the fact that so much of the smaller work which ought to be providing employment to good men, is in the hands of "arçhitects" (don't forget the cedilla) who, under our laws, are allowed to fool the public and practice "arçhitecture", bringing the profession into disrepute, and who accept remuneration for their pitiful work far below the cost of producing a real set of drawings? Not only do they make it difficult for the qualified practitioner to obtain his proper commission, but these are the men whose offices produce so many incompetent, and consequently ill paid, draughtsmen.

A junior can usually obtain higher pay in such an office, for to the "arçhitect" one draughtsman is as good as another and he doesn't know enough to discriminate, but later, when he tries to get into a better office, the junior who has followed the lure of higher pay rather than that of better experience, finds out his mistake.

If architects, instead of turning away small jobs to be grabbed by the above mentioned fraternity, to the former's detriment, would hand such work over to deserving members of their staff to be done outside the office, they would keep their good men and keep them happy and contented, instead of which draughtsmen, to eke out their earnings, do such odd jobs as they can get on the sly and nothing can stop them. Which is the better plan?

Architects could do their share towards improving the lot of draughtsmen by some such method and by getting registration more generally adopted. I would also commend to all the suggestions of the Chicago Architects' Business Association regarding the relations between employers and employees, with the possible exception of the item which suggests that while it is detrimental to the health and well being of a draughtsman to engage in profitable employment "on the side," a certain amount of overtime for the office with or without pay and study, which presumably includes atelier problems with attendant wet towels and midnight oil is a real tonic.

Why could not draughtsmen organize a brotherhood for mutual benefit, with an employment register and benevolent fund, having a branch in each town of any size, where a newcomer could be welcomed and obtain information as to the right kind of offices to seek employment?

Yours truly,

Detroit. A. B. SCARLETT.

Editor ARCHITECTURE,
Dear Sir:

I have read the letter written by the discontented draughtsman, which you published in your last issue, and am herewith sending you my criticism on your comment on his letter.

I am a practicing architect, and have been for the past six years. I am not in the draughtsman class any more, but thoroughly appreciate their position.

The point which this man tried to bring out you have either not understood or tried not to understand. His point is this: That a draughtsman, that is, 80% of the draughtsmen, is receiving a salary of from $20 to $35 a week. When he does obtain a salary of $35 a week, he has to be thoroughly familiar with all the building trades from one end to the other. He has to have a thorough understanding of building construction from A to Z.

The common, ordinary plumber, or bricklayer, or steam-fitter, even the laborer whom we pay $3.00 per day—he spends a couple of years and learns his trade, and receives $6.00 a day, while the draughtsman, who has to spend years in learning his profession, does not get anywhere near their salaries.

This fellow is only looking for his share.

I know out of my own experience that the draughtsman is the most underpaid workingman connected with buildings when you consider what work he has to do, what he has to know, and the front he has to put up before the social world. This, I think, is the point which this man tried to bring out and which you did not get. Yours very truly,

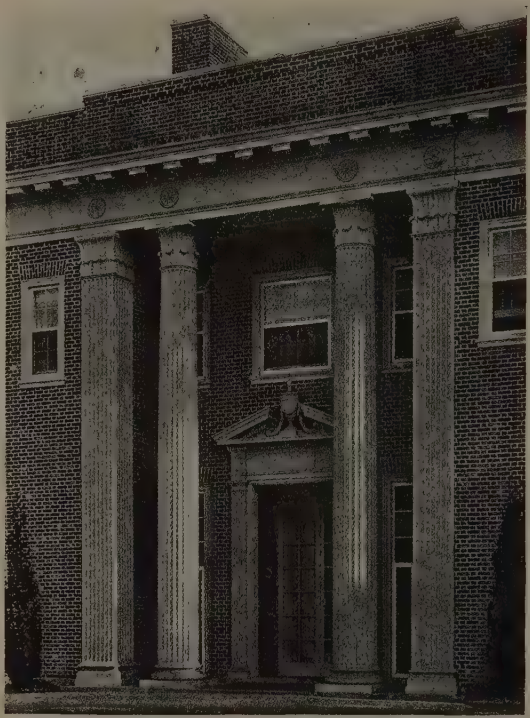
Chicago. JACQUES J. KOCHER.

LEGAL DECISIONS (CONTINUED)

FILING LIENS—LAST WORK DONE.

The Indiana Appellate Court holds that work done by a contractor to remedy a defect in the performance of his work caused by his own negligence, for which he makes no charge, but which is necessary to complete the performance of the contract, may be considered the last work done for the purpose of fixing the time of filing a lien upon the premises under the statute.—Kessler *vs.* Groceries Chemical Works, 113 N. E. 317.


Detail, House, James S. Frick, Guilford, Baltimore, Md.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MONTHLY PICTORIAL REVIEW SHOWING THE BEST WORK PRESENTED BY OUR CONTEMPORARIES.
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II. The Classic Orders of Architecture

By Egerton Swartwout, F.A.I.A.

THE DORIC ORDER

THE column, with its entablature, which, taken in its entirety, is architecturally termed an order, is nothing but an ornamented form of support, and is as old as architecture itself. In the first traces of civilization, where any architectural ruins remain, there are always indications of some form of support other than that of the walls. A tent pole or the trunk of a tree used as a support for the rustic shelter of some savage, a roughly-hewn block of stone set laboriously upright in the ground—all these are the primitive expression of the column. Such an upright support, with the rude beam which it carries, is the prototype from which, by slow degrees, the order, as we now know it, has been developed. In different countries it has developed along different lines and to different degrees of perfection. In Egypt, owing perhaps to physical and climatic conditions, its development is almost entirely lithic, although there is undoubted reason to believe that the column and the lotus cap are expressions in stone of a primitive post, made by binding together numbers of stout reeds; while the cavetto cornice is reminiscent of the ends of the wattled reeds of the clay wall, forced outward at the top by the weight of the earthern roof. However this may be, the Egyptian column, as we find it at the dawnings of history is a well developed stone form, and this at a period when the Babylonian palaces were of sun-baked bricks, and the temples of the Greeks were mere rustic shrines.

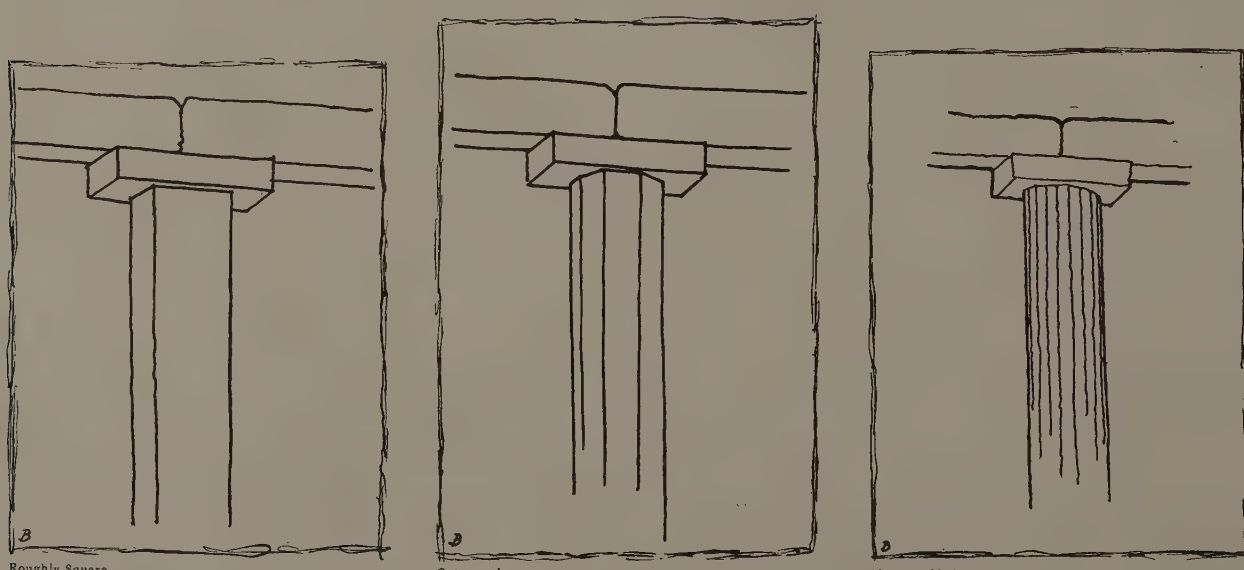
From this priority of civilization and this early development of architecture in stone, there has been a disposition on the part of many archeologists to attribute to Egyptian influences the Doric order, as found in Greece. A claim has been made that certain columns at Beni-Hassan and other places in Egypt are the definite prototypes of this order, and at first sight there seems to be some good reasons for this belief. These columns certainly do bear a general resemblance to the Doric column, and they ante-date the Doric by a considerable period, and it is a well-known fact that the Greek sailors and merchants were at an early age well acquainted with Egyptian

civilization. But it is just this great priority of construction that is suspicious. Why should the Greeks copy an Egyptian form of order already centuries old, found in an out-of-way part of the country; and, more than all, an order which the Egyptians used but little and never developed? Surely the wise

I. So called Proto Doric Order at Beni-Hassan.

Greeks would have copied the fully developed lotus cap and the coilanaglyphic decoration of the monumental temples, if they copied at all. Or even, if it was conceivable that they had adopted the Beni-Hassan column, would they not also have adopted the entablature? But the Beni-Hassan entablature is a distinct reminiscence of the reed and pole type, with its superincumbent earthen roof—absolutely dissimilar to the Doric entablature. This imagined development from an Egyptian prototype has been popular for many years, as it provided the simplest explanation, but it is now generally questioned, and the development of the Doric order sought in Greece itself.

Is it not possible that different nations, working centuries apart, might develop similar types under similar conditions? This is not only conceivable, but probable, especially when the object to be developed is of such a simple type and of such common proportions as the column.



Roughly Square. Octagonal. Sixteen Sided.

II. Development of Primitive Post and Cap.

Primitive man erects a wooden post for the support of his roof. It may be a tree trunk, or it may be roughly squared, according to his knowledge of tools and his ability to use them. On the top of this post he rests his beam, and in order to secure adequate bearing for the beam, he crowns his post with a flat piece of wood. This piece of wood is oblong, and extends on either side of his post, to give better bearing to the beam; it even becomes a bracket at times; and then as he acquires more skill, he chamfers the edges of his square post, and it becomes octagonal; chamfering it again, the post becomes a sixteen-sided pillar, and if these chamfers are slightly hollowed, and thereby lend more grace and color to the shaft, they straight away become flutes. The shaft is tapered towards the top and becomes a more structural form, and a natural form—a form seen in the trunks of the pines around him—and more than all, it is a pleasing form—for the savage is now progressing. He has acquired some knowledge of æsthetic values; he seeks the beautiful; he is groping, a little blindly perhaps, but still laboriously seeking the vague expression of something more beautiful. Similarly, the bracket over the post is found unpleasing; it is unsymmetrical, and found by experience to be unnecessarily long, and it is therefore shortened, and becomes a square—and by that step the savage has reached the same level as the artisan of Beni-Hassan. He has, without copying, arrived at the same natural result. He goes further. The transition between the round and the square is still displeasing; it is too abrupt. He introduces a roughly rounded moulding between the top of the shaft and the block or abacus, and the thing is done. He has made a Doric column. It is a simple thing really, an easy transition from the square to the round, which is the fundamental principle of all decorative forms of support, the basis of all orders—and, considered in this light, there are only two Classic orders, two definite forms, although these two have the one common origin. The first is a rational structural form, which may be simple, as the Doric, or decorated, as the Corinthian; and the second is unstructural, a purely decorative form—the Ionic. If this seems a startling statement, look at it graphically, or, better still, consider it from a model. What is the echinus of a Doric cap but a method of transition from the round to the square. The same transitional form is to be observed in the bell of the Corinthian cap. It is decorated, it is true, and the abacus has been lightened, and has taken on a pleasing curve, but the same principle is there. Seen in perspective, the relation between the Doric and the Corinthian is similar, the transition between the

two orders being shown, though not as a chronological development, in the capital of the little Clypsedra of Andronicus Cyrrhestes, better known as the Tower of the Winds.

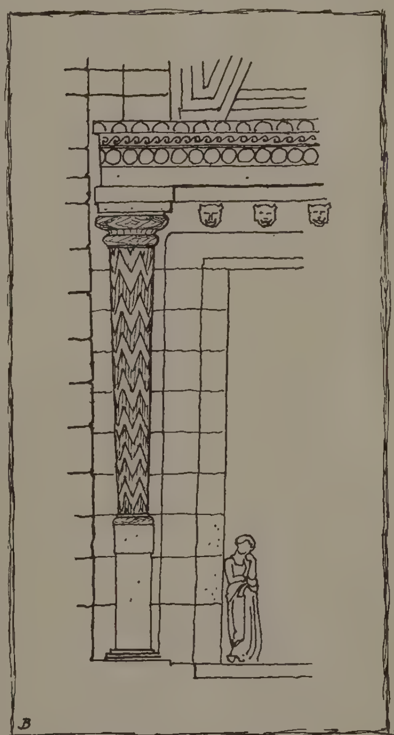
In the case of the Ionic order, which will be considered in detail in another chapter, the origin is the same, but its development has been along less rationally constructive lines. The bracket over the column has retained its elongated form, the ends have become rounded and decorated with a scroll. It is a purely ornamental and not structural form.

III. Similarity in outline between Doric and Corinthian.

Any hypothesis of a wood, and not a lithic origin for the Doric column has many opponents and few defenders. The opponents start with the assumption that the Doric form is essentially lithic. They point always to the prototype of Beni-Hassan, and to the extreme heaviness of the columns in the earlier temples of Sicily, as compared with the loftier proportions of the Parthenon, and the meagre outlines of the later work. This is, they say, the natural development of time. The early columns were unduly heavy, because of their development from the rough-hewn boulders, and they became gradually slighter as art progressed and construction was better understood, while the reverse would happen if they were copied from a wooden prototype. But, although they decry a wood origin for the column, they accept it willingly for the entablature. They fail to explain why a stone form, copied from Egypt, is used for the column, in conjunction with an entablature which they admit is a stone expression of a wooden prototype, a prototype not taken from Egypt, as was the column, but of distinctly Grecian origin.

IV. Capital, Tower of the Winds.

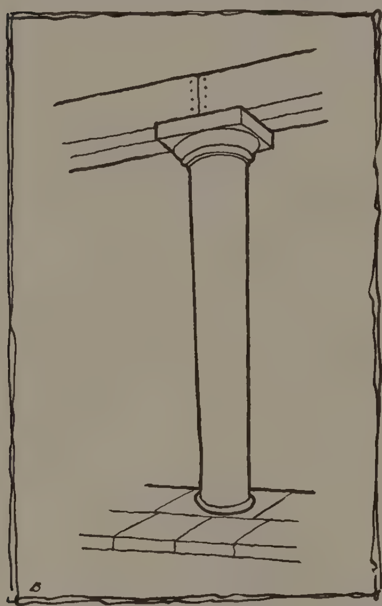
On the other hand, it is sometimes held, notably by Perrot and Chipiez that, while the columns as well as the entablature of the primitive Greek temples were wood, the prototype of these wooden columns must be sought in Mycenae. They claim that the curious columns at the entrance to the Tholos of Mycenae were stone expressions of the wooden columns of the period; that their wooden origin is plainly shown by their unusual shape, and that this shape is even now commonly used as a wooden form for table and chair legs and the like; that these wooden columns rested upon stone sockets, to give them greater stability, and to prevent decay; and that these sockets are the primitive expression of the Classic base. As evidence that the wooden column was used extensively in Greece, reference is made to an extract from Pausanias, who in the Second Century, A. D., in describing the Heraion at Olympia, says that there was still one wooden column remaining. From this remark, and from certain records, it is generally held that the original Heraion, which certainly antedated the first Olympiad, and which, therefore, was probably built in the early part of the Eighth Century, B. C., was constructed entirely of wood, with the exception of the stylobate and cella, the latter being originally brick; and that being a shrine of especial sanctity and the repository of the most precious ornaments, for it was here that the Hermes of Praxiteles was found, the wood columns were either, on account of their decay, or as an act of piety, replaced one by one by columns of stone. This is evident, not only from the records, but from the curious fact that nearly all of the fragments of columns and of caps which remain are of different sizes and outlines, and undoubtedly belong to different eras; and it is, therefore, probable that the one column observed by Pausanias was the last remaining vestige of the wooden colonade which once existed. The entablature, as well as the roof, was undoubtedly of wood, as it is inconceivable that wooden columns would be used to support an entablature of stone, and this is borne out by the fact that no vestiges of any stone entablature are found in the ruins.



V. Tholos of Mycenæ.

The hypothesis, then, of Perrot and Chipiez would seem to be that the early form of wooden column in the Heraion and elsewhere was similar to the inverted Mycenian prototype, but that, when the Greeks began to use stone for their columns, they considered that the inverted, truncated cone was not a structural lithic form, and therefore they inverted the column, so that it tapered to the top, instead of to the bottom. This theory, though ingenious, raises several striking objections. Is it safe to assume that the columns at Mycenae were copied from a wood prototype, simply because the same shape is a common form in wood furniture? While it is perfectly true that this form is graceful, when used for such purposes, it is inconceivable in its use as a column, especially for a series of free standing columns or for a portico. A temple the size of the Heraion, with its comparatively large columns, would be ridiculous if those columns were practically inverted, nor does it

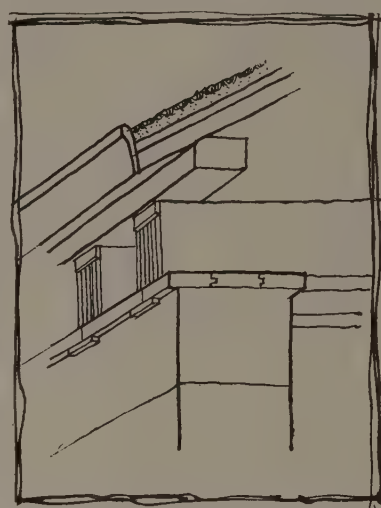
seem that this form is a structural one for a wooden column of any size. It is not only opposed to every law of stability, but it is bad structurally. The logical form to give the greatest strength would perhaps be a column that was slightly bowed in the middle. There is apparently every indication that these columns of Mycenæ were expressions in stone, not of a wooden, but of a metal column, or possibly a wooden core covered with metal. The curious zig-zag ornament which is a distinct reminiscence of a beaten metallic form, would tend to confirm this, as would also the very general use of gold or bronze plating in the works of that period. Another objection would be the sudden inversion of the column in the change from wood to stone. The development of the column and the temple is everywhere so gradual that such a revolutionary change seems almost inconceivable, and further, the Heraion would have presented a most curiously unpleasing appearance with half of its columns retaining the inverted wooden form, while the other half were stone, with the normal shape.



VI. Primitive Greek Column after Parrot and Chipiez.

If, then, the Mycenian prototype is discarded, it would appear that there was in Greece from the earliest times a wooden form of column, and that this wooden column was not dissimilar in appearance from the Doric column as we see it in stone, with the exception that, on account of the material used, it was undoubtedly of slighter proportions. Viewed in this light, the Heraion with its wooden columns becomes an architectural possibility, the substitution of stone columns for the wood becomes possible without committing an architectural solecism, and the Heraion is then the prototype of the Parthenon.

As to the entablature of the Doric order, it is now a universally accepted fact that the origin of the most monumental form known to architecture must be sought in the rough wooden covering of the prehistoric Greek temples, and further, that these early temples were probably a development of the Mycenian megaron, the great house of the tribal leader or petty king. In this megaron may be traced the origin of the cella or naos of the later temple; the megaron being usually a small rectangular building, with either a door at the narrow end, or later a shallow recessed portico, the roof over the portico being supported by two primitive columns in antis, a form which, even in Classic times, is used for the smaller temples. This megaron was covered, not with a flat roof of earth, as was customary in the drier climates of the East, but with a pitched roof, supported by simple carpentry forms, and probably in the earlier times covered with a protective coating of clay. The heavy beams or girders which carried the kingpost for the support of the rafters rested on and projected to the outer edge of the rough stonewall, the intervals between these girders being probably in the early times left open. The beams themselves were possibly composite, as with the limited means at their disposal it would have been difficult to have fabricated or erected a solid wooden beam of the size that the early carpenter seemed to think necessary. If it can be assumed that there were three beams making up the one solid girder, a construction which is recalled in the vertically tripartite division of the stone architraves of Classic work, it would be extremely natural and in keeping with the chamfering of the shafts of the columns also to chamfer the edges of these beams. This, then, would form a primitive triglyph. It is natural also to assume that on top of the rough stone wall was placed a wall plate to provide a better bearing for the ends of the girders, and to secure this plate to the wall below small pieces of wood being the regulæ found under the triglyphs, the guttæ being the wooden pegs by which these were secured to the projecting wall plate, which is expressed by the tænia. In a similar manner, the soffit of the Classic cornice is reminiscent of the rafters. The slope of the roof is clearly indicated, the mutules recalling the covering of the rafters, secured in the same manner as the tænia by the wooden pegs or guttæ. The projecting ends of the rafters were then covered by the cymatium, which not only made a more finished appearance, but held in place the clay roof. It is probable that in the primitive form of the megaron or the small temple in antis the entablature over the columns was not originally treated in the same manner as the entablature of the side walls; in other words, the primitive triglyphs possibly did not appear here or in the rear wall, but were after-

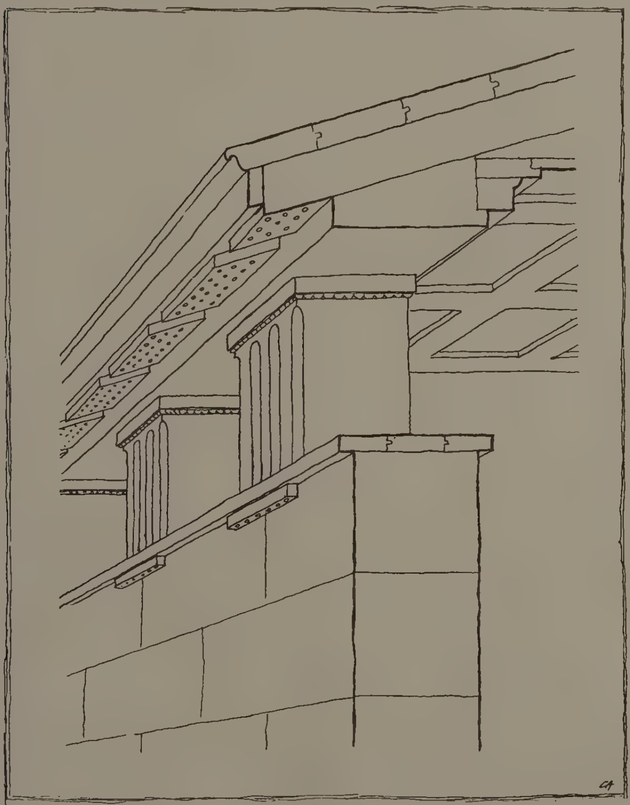


VII. Wooden Origin of the Doric Entablature.

VIII. Doric Entablature in Wood after Gaudet.

wards added as a purely decorative form, to complete the symmetry of the entire building. Similarly, when the primitive temple was enhanced in dignity by the surrounding portico of columns, becoming in this way the prototype of the peripteral stone temple, the triglyphs and metopes were used purely as decorative forms, the architrave representing a portion of the wall of the temple itself. In this translation of wooden forms the soffit of the cornice gradually lost its original significance; the upward inclination does not always coincide with the slope of the roof, and this same inclination was even repeated at the front and rear, for its decorative and symmetrical effect.

It has been held by some distinguished archeologists that the triglyph did not represent the ends of the beams, but that it was a distinctly stone form, even in the earlier temples. In this hypothesis, it was assumed that the roof beams rested not on the wall but on a series of short stone uprights, which were channeled like the columns below, and that the spaces between these stone supports were left open for the purpose of admitting light, or were filled, either permanently or on occasion, with trophies and offerings to the gods. The reasons given for this hypothesis seem to be chiefly that in the Classic temples the level of the ceiling of the pteroma is above the upper level of the triglyphs, and that the pteroma ceiling was undoubtedly in the same relative position as the ceiling of the primitive naos, and that the triglyphs, therefore, cannot be held to indicate the ends of the beams. It would seem, however, that there was not



IX. Stone Origin of Triglyphs after Gaudet.

sufficient room above the triglyphs for the heavy roof beams that, from their lack of knowledge of the principles of the truss, the Greeks thought necessary; and if it is granted that by the time the temples were made peripteral the triglyph and metope forms had become established, or had perhaps acquired some mystical significance, and were used frankly for their decorative or religious value, then it is evident that these reasons for the stone origin of the triglyph cease to have significance.

Another point which is advanced in support of this theory is based on an extract from Euripides. In Iphigenia in Tauris, Orestes is made to enter the temple through the metopes, or rather between the triglyphs, steal the sacred statue of the goddess, and make his escape by the same difficult route. The assertion is made that if the triglyphs were conceived to be the beams of the ceiling of a small non-peripteral temple, Orestes, on passing through the metopes, would find himself above the

X. Section through Pteroma,

ceiling; otherwise, if the temple were conceived to be peripteral, he would go to the extreme trouble of clambering through a narrow hole in order to gain access to the perfectly open portico of the temple, or possibly find himself in the pronaos, shut off by the brazen gates from the image he sought; and there has also arisen in this connection a question as to the exact meaning of the Classic expression "metope," which would seem from its derivation to mean, "the space between the openings," and this has been interpreted by some to mean that the metopes were always closed, and that reference was made to an opening left in the wall for the reception of the beams, it being advanced in support of this later theory that in no Classic work is the wall behind the metope constructed in a way which would indicate that there was once an opening at that point, and further, that in some of the most ancient temples in Sicily the triglyph was sometimes cut from the same piece of stone as the metope itself. Objection is made to the designation in this theory of the space left for the reception of beams as an opening; if such an opening did exist, its duration was short, merely during construction, and, therefore, it could hardly give its name to an important architectural treatment; and another derivation has been found for the word "metope" from the Greek word for

XI. Section of Parthenon after Ferguson.

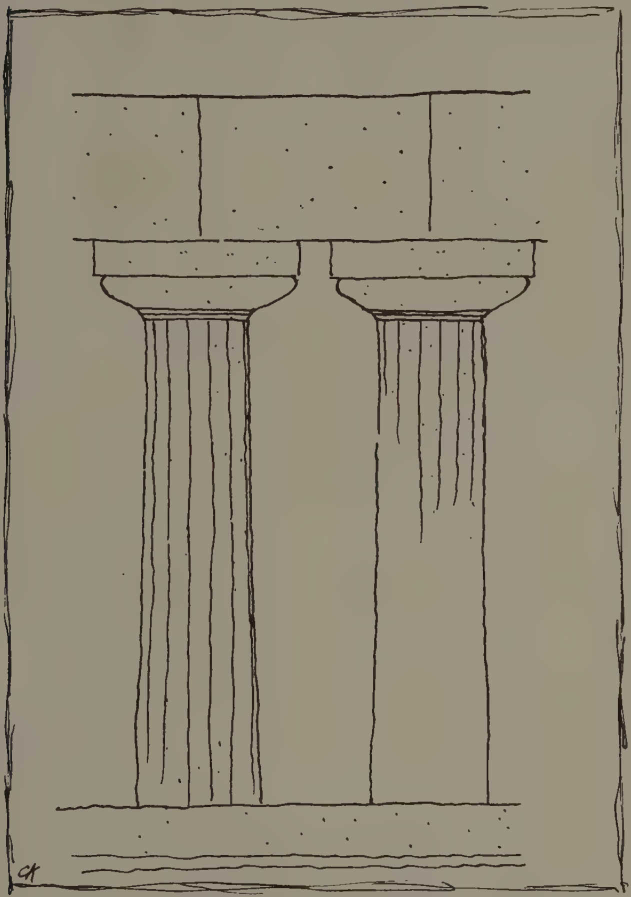
"forehead" or "front," with probable reference to the prominence of the sculptured metope.

Whatever may be the philological derivation of the metope, Euripides' statement has never been definitely understood. If it is to be imagined that Euripides referred to a small temple in antis, it could be well conceived that the ceiling was not closed in below the level of the beams, but was open to the rafters above, in which case the way was clear for Orestes. That these rafters were originally left exposed is shown by Homer's description of the slaying of the suitors in the Odyssey when Pallas Athenæ perches as a sparrow on the roof beams. On the other hand, it seems more probable that the temple referred to by Euripides was similar to the Classic temples with which he was familiar. Iphigenia is represented as the high priestess and a very important personage in Tauris, and it seems highly propable that Euripides would imagine her temple to be of the largest and finest type, rather than a small primitive temple, which would have been more historically correct. This would be following the analogy of Shakespeare, who in placing his characters and scenes in distant lands and in early times, still conceived them as of his own period. If this point of view can be considered, it gives rise to a rather interesting speculation as to the means by which Orestes entered the temple, as in that case there could be no entrance through the metopes. Could it be possible that the reference here was made to some openings in the roof, such as have been suggested by Mr. Ferguson for the lighting of his temples? If there were, as he has suggested, certain small hypæthral openings, masked on the inside by some form of triglyph decoration, these would provide an entrance to the shrine which would be as easy of access as through the metopes, and possibly form a place of concealment in case the robbery was interrupted. It is known that there was some sort of a space above the roof, because there is a record that in the defense of the Heraion a wounded Greek secreted himself there, and his body was not discovered until many years later.

XIII b. Relation of Architrave and Abacus, Parthenon.

Allusion has been made to an objection brought forward to the wood origin of the Doric column, based on the fact that the columns in the early temples were of excessive thickness, and that this proportion gradually diminished to the perfect proportions of the Parthenon, and beyond that to the meager outlines of the latter work, the idea being that the reverse would happen if the stone columns were copied from a wooden prototype. As a matter of fact, is not this gradual diminution a perfectly natural result of progress and development, not only

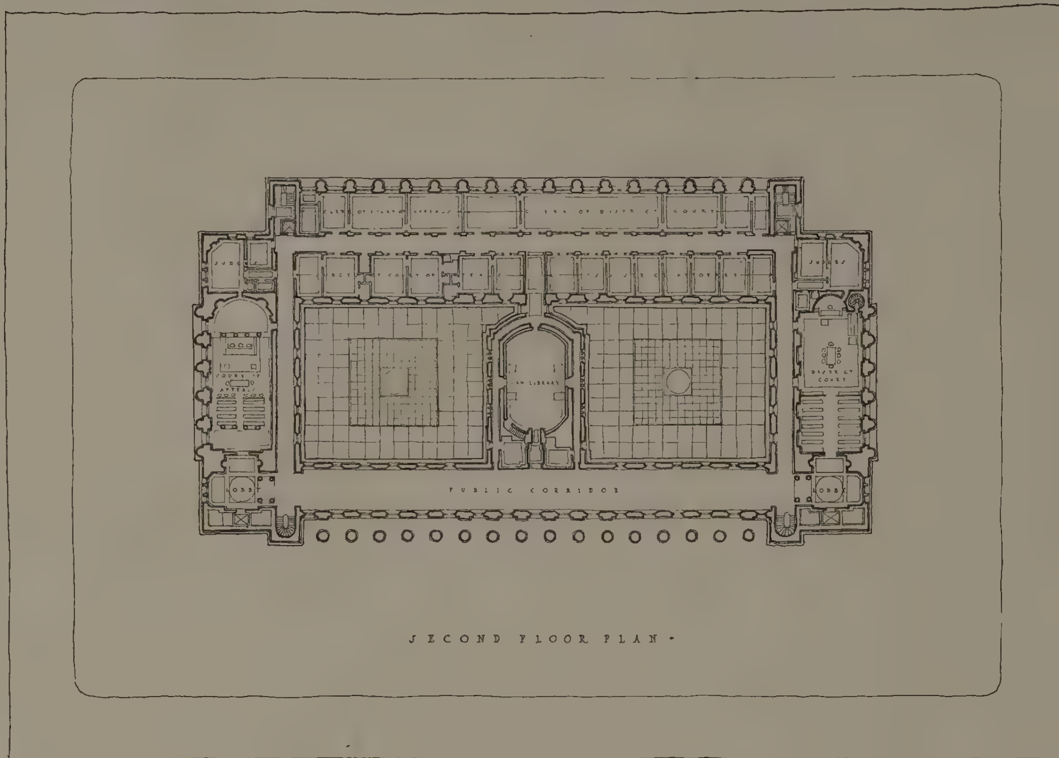
from an æsthetic, but from a structural point of view? Is it not always the case that the first use of stone as a building material is hampered by excessive timidity? Stone was a new

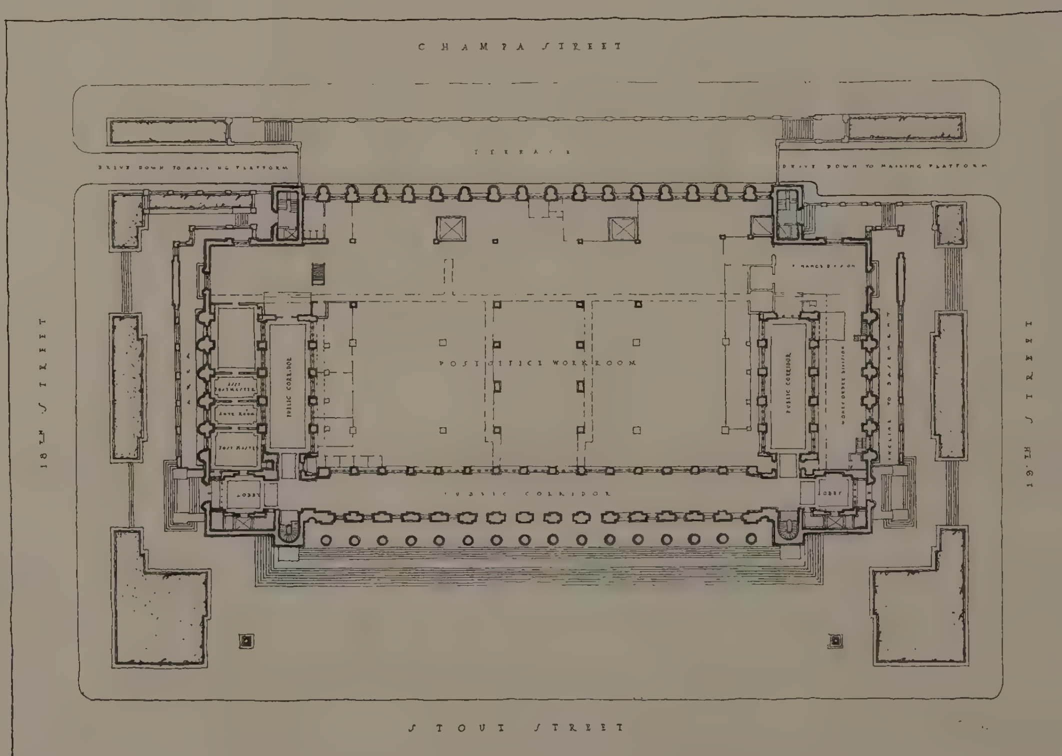


XII. Columns, Temple of Artemis, Syracuse.

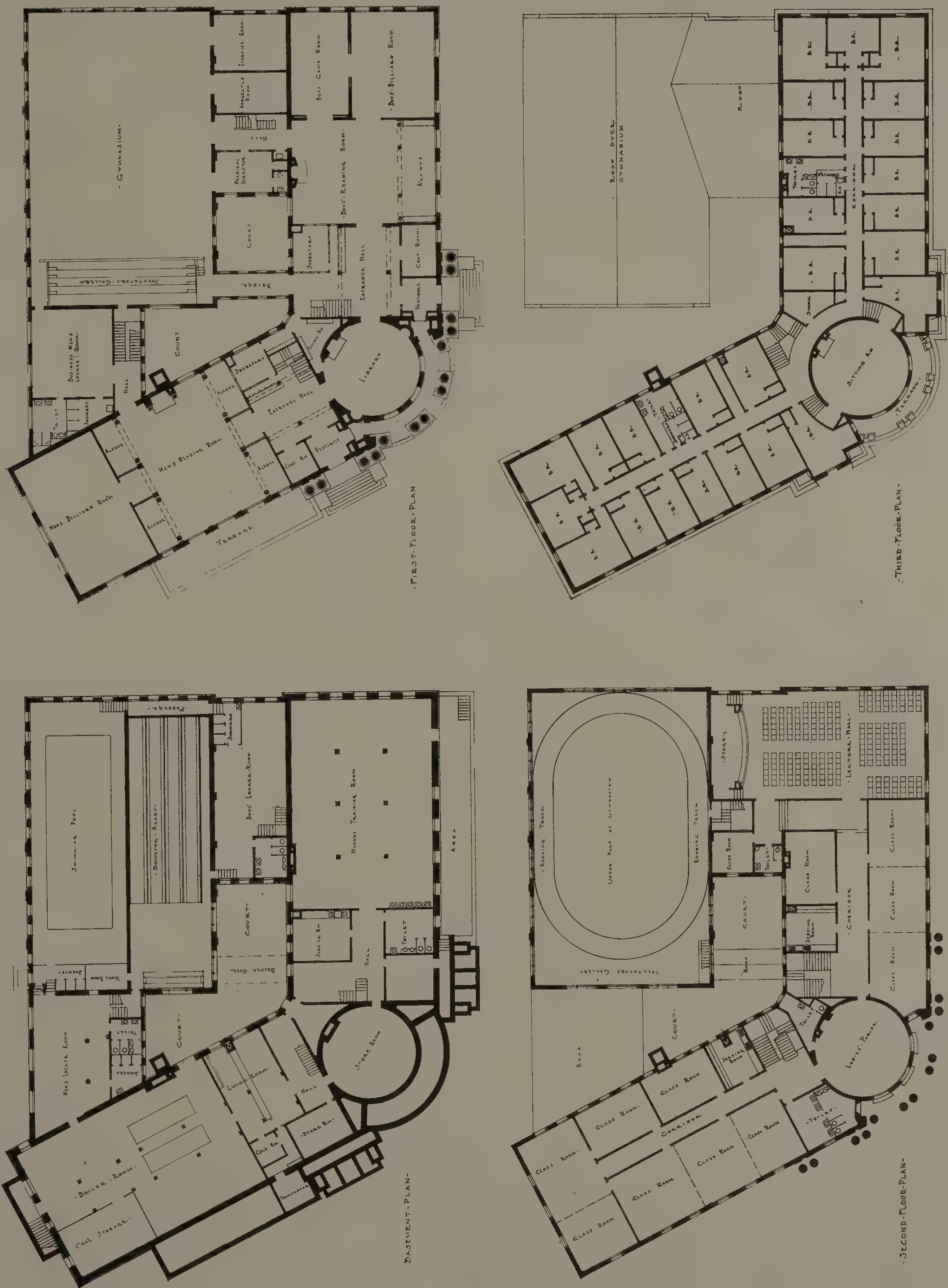
material, and its primitive users were unwilling to trust too much to its strength. The walls of Assyria and the columns and pylons of Egypt greatly exceeded the structural strength which was demanded from them. As time progressed, and it was found that stone would safely bear a greater weight than had been previously intrusted to it, the columns would gradually diminish in size, until from the massive proportions of Sicily they had attained the slightness of the later temple at Cori. It may also be possible that in the early times there were certain failures of lintels or columns, due to the presence of dry seams or other structural defects which were then unsuspected. In any event, the first use of stone by the Greeks, as by the other nations of antiquity, was marked by an excessive timidity. This extended not only to the columns but to the architrave supporting the entablature. In the very early examples, the excessively heavy columns were placed so near together that their projecting abaci nearly touched; an outline of these columns in their relation to each other and the entablature above recalling very strongly the stepped domes of the Mycenian age. That this extreme projection of the abacus was merely for the purpose of reducing the span of the architrave, is shown by the fact that the primitive architrave was no wider than the upper diameter of the column, and consequently, viewed across the corner, the load supported by the abacus was not at all in keeping with this excessive projection. This was early apparent to the Greeks, and not only was the projection of the abacus gradually reduced, but the architrave itself was widened, until in the Parthenon it projected considerably beyond the upper face of the column. This gradual development was dictated by purely architectural reasons, and forms an important step in a hypothesis regarding the proper relation between the lower face of the architrave and the upper face of the column or pilaster, which will be the subject of a later article.

XIII a. Primitive relation of Architrave and Abacus, Paestum.



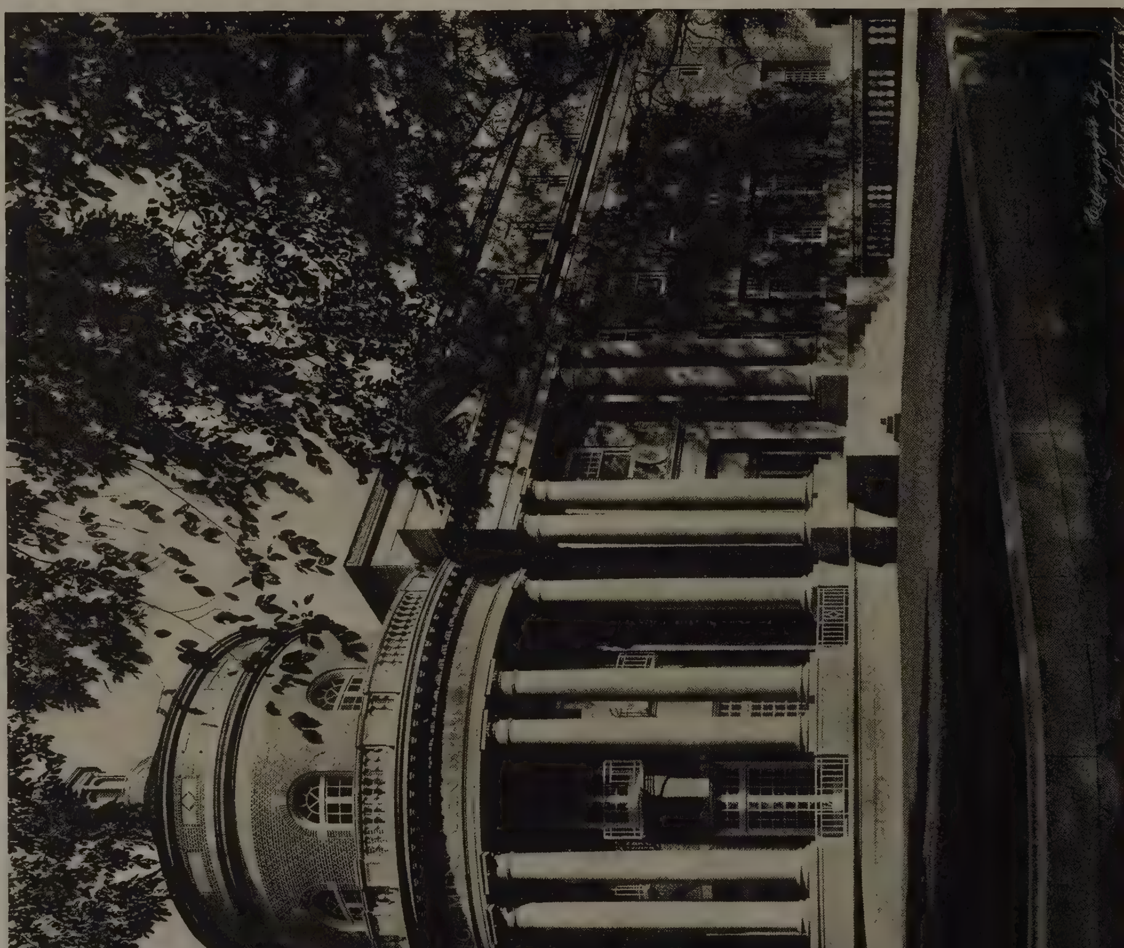


PLANS, U. S. POST OFFICE AND COURT HOUSE, DENVER, COLO. Tracy, Swartwout & Litchfield, Architects.



M. L. & H. G. Emery, Architects.

PLANS, YOUNG MEN'S CHRISTIAN ASSOCIATION BUILDING, GREENWICH CONN.



YOUNG MEN'S CHRISTIAN ASSOCIATION BUILDING, GREENWICH, CONN.

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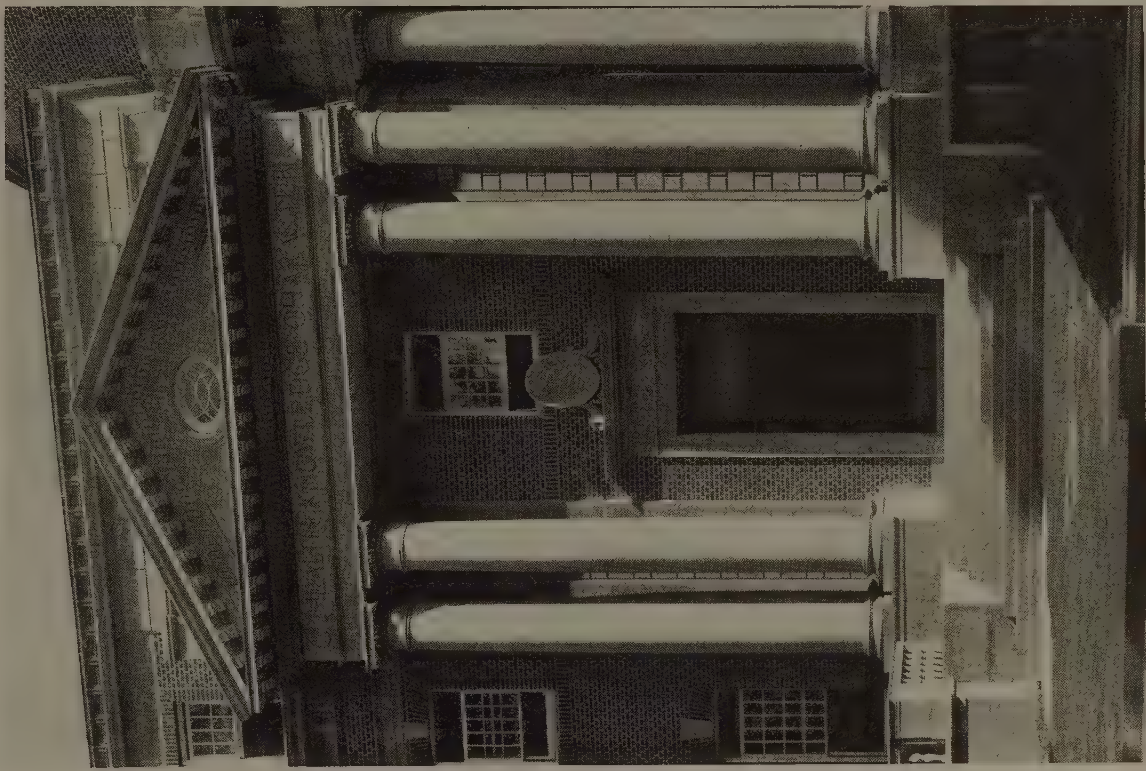

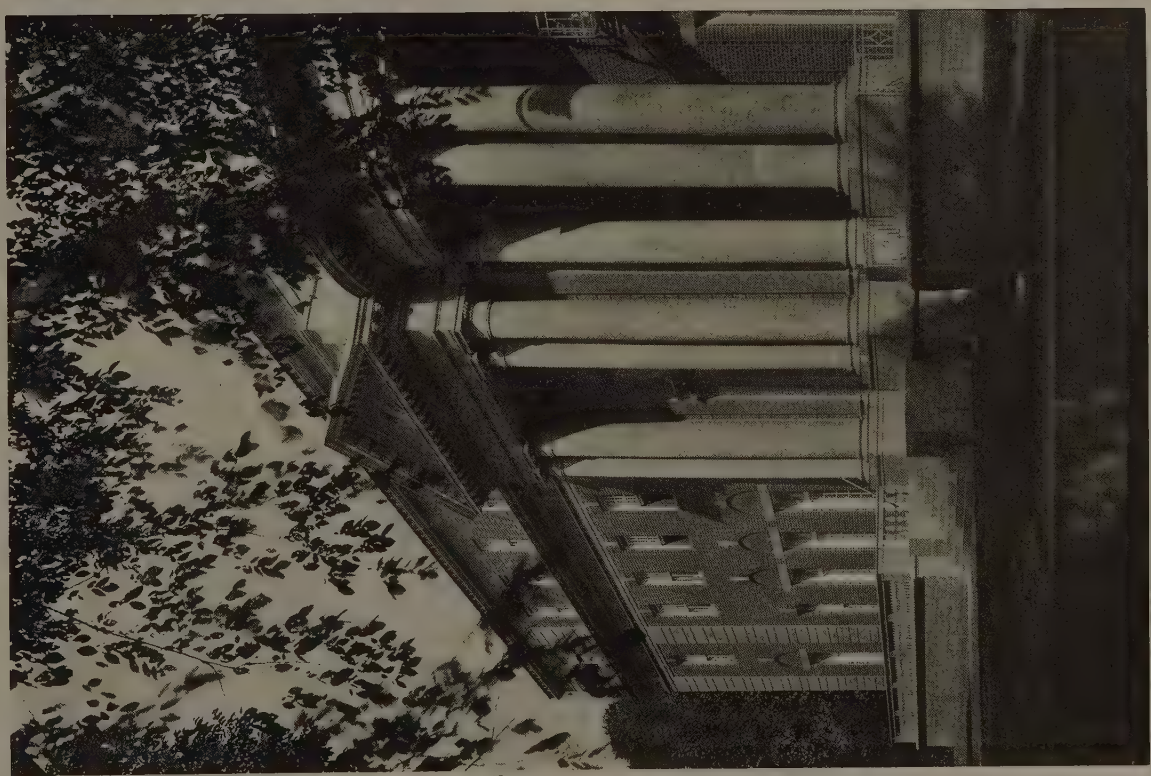

DETAILS, YOUNG MEN'S CHRISTIAN ASSOCIATION BUILDING, GREENWICH, CONN.

M. L. & H. G. Emery, Architects.

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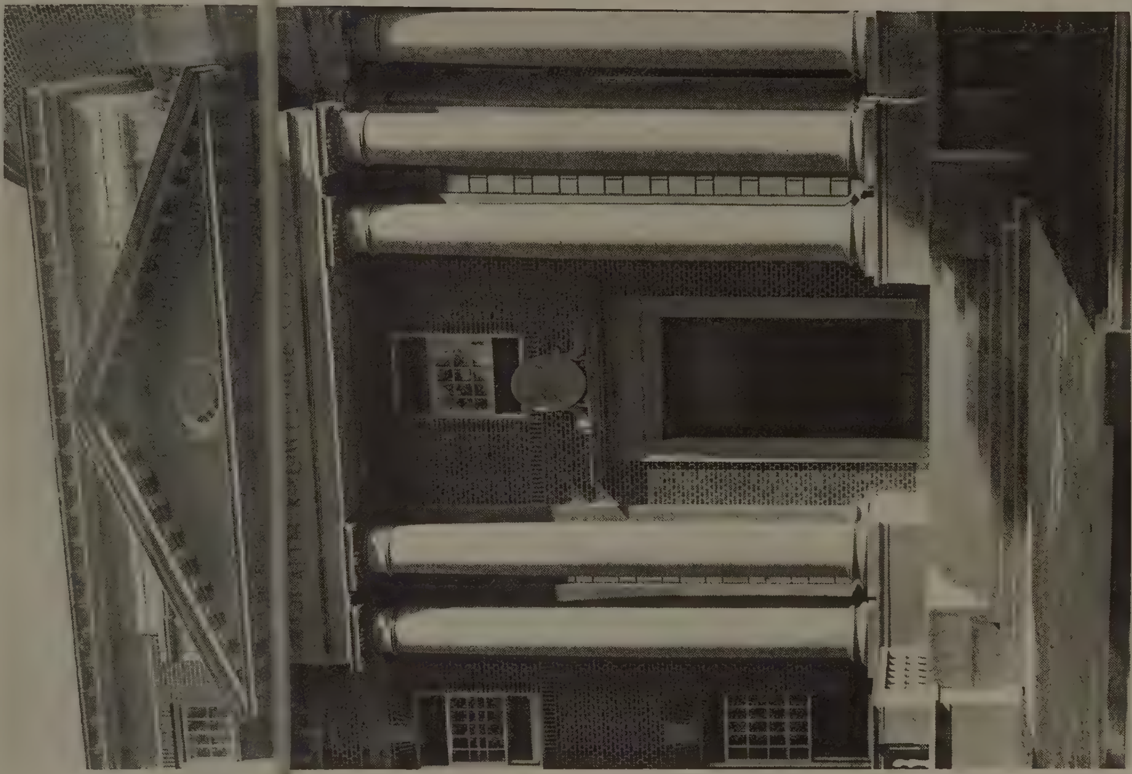
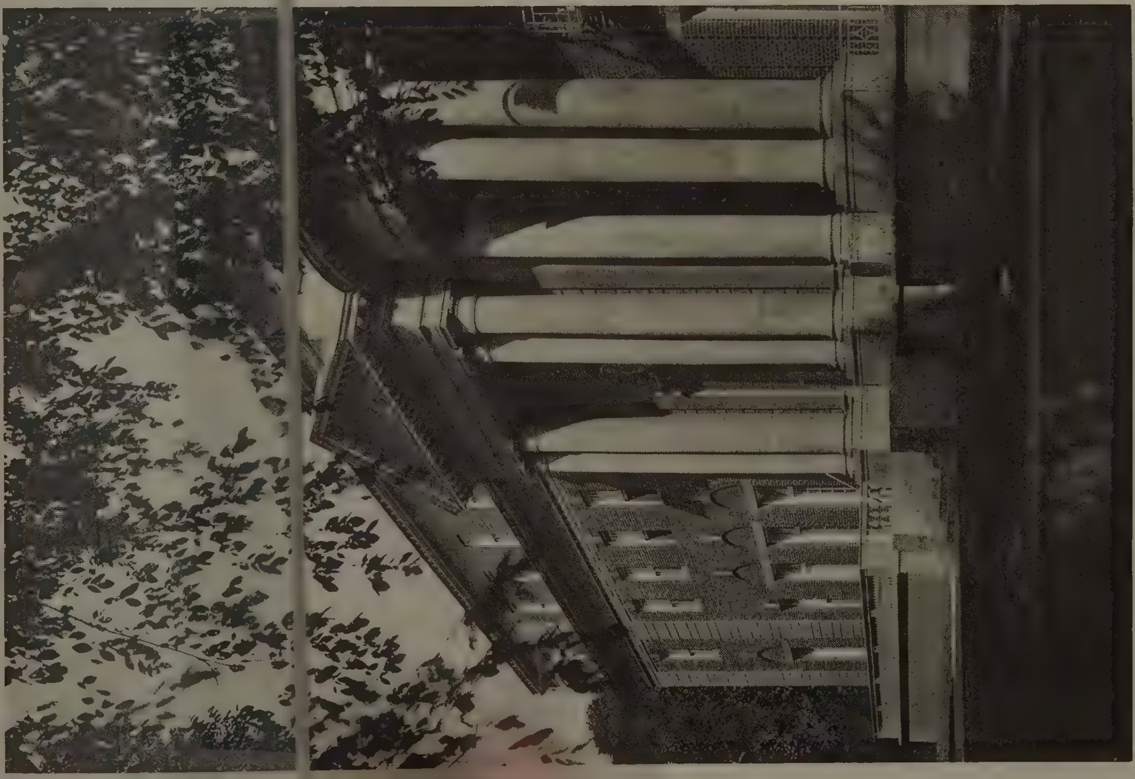
YOUNG MEN'S CHRISTIAN ASSOCIATION BUILDING, GREENWICH, CONN.





DETAILS, YOUNG MEN'S CHRISTIAN ASSOCIATION BUILDING, GREENWICH, CONN.

M. L. & H. G. Emery, Architects.

Library.

Men's Reading Room.

YOUNG MEN'S CHRISTIAN ASSOCIATION BUILDING, GREENWICH, CONN.

M. L. & H. G. Emery, Architects.

XVII. Engineering for Architects

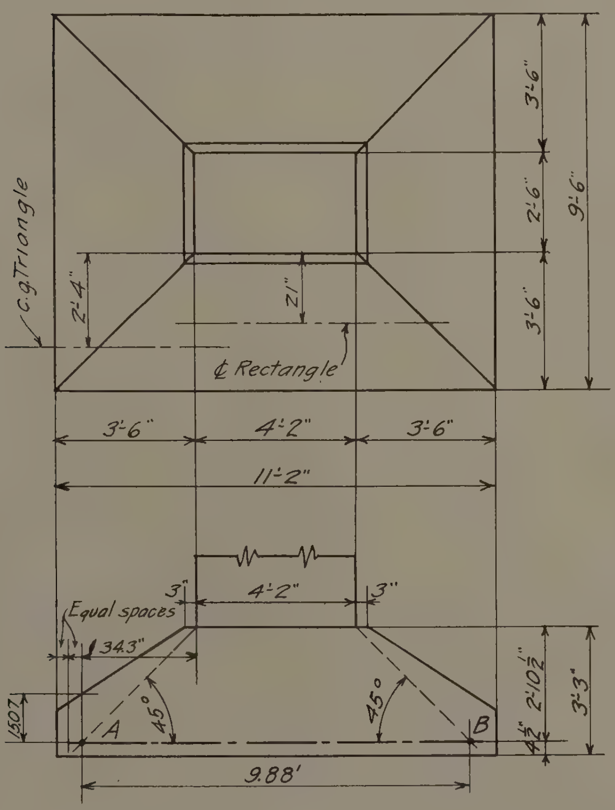
By DeWitt Clinton Pond, M. A.

Mr. Pond has charge of the practical course in Architectural Engineering at Columbia University. He is the author of "Engineering for Architects" recently published in book form. This series, started in July, 1916 ARCHITECTURE, is a continuation of the previous series concluded in the issue of June, 1915.

IN the last article the problems involved in the design of footings resting on soil and under interior columns were discussed. It was assumed that such columns would be round, and the footings were made square as this is the most economical shape for any footing.

In case the column had been rectangular the most economical method would have been to have made the footing rectangular and of such a size that the projection of the footing beyond the column or pier would have been the same on all sizes. Suppose that the column or pier were 30 inches by 50 inches. According to the information given in the September issue of ARCHITECTURE, the allowable load on such a support can be found to be slightly more than 800,000 pounds, but for the purposes of this article it will be assumed that the load on the footing will be 800,000 pounds and for the present the weight of the footing itself will be considered as 50,000 pounds. The total load on the soil will be 850,000 pounds.

It will also be assumed that the bearing capacity of the soil will be 4 tons per square foot. The area of soil, over



FIGVRE 95

which the 850,000 pounds must be spread, will be 850,000 ÷ 8,000 = 106.25 square feet. If the base is made to project 3 feet and 6 inches beyond the column on all sides the footing will measure 9 feet and 6 inches by 11 feet and 2 inches, and the area of this footing will be 106.32 square feet.

In the previous article—Article XVI—the square base was divided into four parts by means of diagonals. In Fig. 95 the method of dividing the present footing into four parts is shown. The tendency of the footing to bend up around the edges of the pier will be considered first. The tendency of the footing to bend around the long side of the rectangle will be caused by the pressure of the earth on a portion of the base which can be divided into a rectangle, measuring 4 feet and 2 inches by 3 feet and 6 inches, and two 45 degree triangles, the legs of which measure 3 feet and 6 inches. The area of the rectangle will be 14.56 square feet, and the area of the two triangles will be 12.25 square feet.

The pressure of the soil will equal 800,000 pounds divided by 106.32, which will give the pressure per square foot as 7,520 pounds. It will be noticed that the weight of the footing itself is not considered as this will not tend to produce bending in the footing itself. The pressure on the rectangle will be $14.56 \times 7{,}520 = 109{,}490$ pounds, and the pressure on the two triangles will be $12.25 \times 7{,}520 = 92{,}120$ pounds.

The moment caused by the rectangle will be equal to the pressure—109,490 pounds—multiplied by one-half of the altitude in inches. The altitude in this case is 3 feet and 6 inches or 42 inches, and so the moment will equal $109{,}490 \times 21 = 2{,}295{,}300$ inch-pounds.

The moment caused by the two triangles will equal the pressure—92,120 pounds—multiplied by two-thirds of the altitude, or $92{,}120 \times 42 \times 2/3 = 2{,}579{,}400$ inch-pounds.

The total moment will equal $2{,}295{,}300 + 2{,}579{,}400 = 4{,}874{,}700$ inch-pounds. By similar calculations it can be found that the moment around the short edge of the pier will be 3,971,200 inch-pounds.

As in the case of the square footing under the round, interior column, discussed in the last article, it will be necessary to divide each moment by the width of the pier plus six inches in order to find the moment per foot of beam. If there is any doubt in the architect's mind as to why this is done he should look over again Article XVI.

The pier is 4 feet and 2 inches long by 2 feet and 6 inches wide and so the larger moment should be divided by 4.66 feet and the smaller moment by 3 feet. $4{,}874{,}700 \div 4.66 = 1{,}046{,}500$. $3{,}971{,}200 \div 3 = 1{,}323{,}730$. The depth of the footing can be figured as follows:

$$d^2 = 1{,}323{,}730 \times 8/7 \div 1{,}462.5 = 1{,}034.$$

$d = 32.1$ inches. The actual depth will be $4\frac{1}{2}$ inches greater than this on account of the fact that there must be 4 inches of concrete under the steel.

This depth must be checked for punching shear. The distance around the pier will measure 160 inches, and the area of this pier is 10.4 square feet. The area of the footing equals 106.32 square feet and so the net area, outside of the pier, will be $106.32 - 10.4 = 95.92$ square feet. The upward pressure of the soil was found to be 7,520 pounds per square foot, and the shearing force will be $95.92 \times 7{,}520 = 721{,}400$ pounds. The distance around the pier, multiplied by seven-

Continued page 243

Library.

Men's Reading Room.

YOUNG MEN'S CHRISTIAN ASSOCIATION BUILDING, GREENWICH, CONN.

M. [illegible] & H. G. Emery, Architects.

XVII. Engineering for Architects

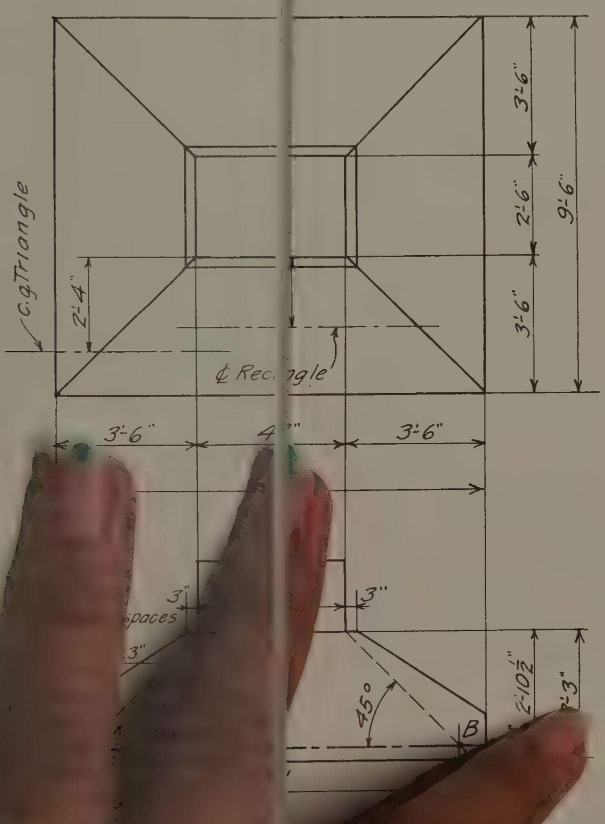
By DeWitt Clinton Pond, M. A.

Mr. Pond has c ge of the practical course in Architectural Engineering at Columbia University. He is the author of "Engi ring for Architects" recently published in book form. This series, started in July, 1916 AR TECTURE, is a continuation of the previous series concluded in the issue of June, 1915.

IN the last article the p lems involved in the design of footings resting on soil nd under interior columns were discussed. It was assumed t such columns would be round, and the footings were made uare as this is the most economical shape for any footing.

In case the column h been rectangular the most economical method would have en to have made the footing rectangular and of such a size hat the projection of the footing beyond the column or pier ould have been the same on all sizes. Suppose that the col n or pier were 30 inches by 50 inches. According to the i ormation given in the September issue of ARCHITECTURE, th llowable load on such a support can be found to be slightly re than 800,000 pounds, but for the purposes of this article will be assumed that the load on the footing will be 800, pounds and for the present the weight of the footing its will be considered as 50,000 pounds. The total load on e soil will be 850,000 pounds.

It will also be assume that the bearing capacity of the soil will be 4 tons per sq e foot. The area of soil, over



be 850,000 ÷
made to project
l sides the footing

will measure 9 feet and 6 inches by 11 feet and 2 inches, and the area of this footing will be 106.32 square feet.

In the previous article—Article XVI—the square base was divided into four parts by means of diagonals. In Fig. 95 the method of dividing the present footing into four parts is shown. The tendency of the footing to bend up around the edges of the pier will be considered first. The tendency of the footing to bend around the long side of the rectangle will be caused by the pressure of the earth on a portion of the base which can be divided into a rectangle, measuring 4 feet and 2 inches by 3 feet and 6 inches, and two 45 degree triangles, the legs of which measure 3 feet and 6 inches. The area of the rectangle will be 14.56 square feet, and the area of the two triangles will be 12.25 square feet.

The pressure of the soil will equal 800,000 pounds divided by 106.32, which will give the pressure per square foot as 7,520 pounds. It will be noticed that the weight of the footing itself is not considered as this will not tend to produce bending in the footing itself. The pressure on the rectangle will be $14.56 \times 7{,}520 = 109{,}490$ pounds, and the pressure on the two triangles will be $12.25 \times 7{,}520 = 92{,}120$ pounds.

The moment caused by the rectangle will be equal to the pressure—109,490 pounds—multiplied by one-half of the altitude in inches. The altitude in this case is 3 feet and 6 inches or 42 inches, and so the moment will equal $109{,}490 \times 21 = 2{,}295{,}300$ inch-pounds.

The moment caused by the two triangles will equal the pressure—92,120 pounds—multiplied by two-thirds of the altitude, or $92{,}120 \times 42 \times 2/3 = 2{,}579{,}400$ inch-pounds.

The total moment will equal $2{,}295{,}300 + 2{,}579{,}400 = 4{,}874{,}700$ inch-pounds. By similar calculations it can be found that the moment around the short edge of the pier will be 3,971,200 inch-pounds.

As in the case of the square footing under the round, interior column, discussed in the last article, it will be necessary to divide each moment by the width of the pier plus six inches in order to find the moment per foot of beam. If there is any doubt in the architect's mind as to why this is done he should look over again Article XVI.

The pier is 4 feet and 2 inches long by 2 feet and 6 inches wide and so the larger moment should be divided by 4.66 feet and the smaller moment by 3 feet. $4{,}874{,}700 \div 4.66 = 1{,}046{,}500$. $3{,}971{,}200 \div 3 = 1{,}323{,}730$. The depth of the footing can be figured as follows:

$$d^2 = 1{,}323{,}730 \times 8/7 \div 1{,}462.5 = 1{,}034.$$

$d = 32.1$ inches. The actual depth will be $4\frac{1}{2}$ inches greater than this on account of the fact that there must be 4 inches of concrete under the steel.

This depth must be checked for punching shear. The distance around the pier will measure 160 inches, and the area of this pier is 10.4 square feet. The area of the footing equals 106.32 square feet and so the net area, outside of the pier, will be $106.32 - 10.4 = 95.92$ square feet. The upward pressure of the soil was found to be 7,520 pounds per square foot, and the shearing force will be $95.92 \times 7{,}520 = 721{,}400$ pounds. The distance around the pier, multiplied by seven-

Continued page 243)

HOUSE, F. HUNTINGTON BABCOCK, OYSTER BAY, LONG ISLAND.

Aymar Embury II. Architect.

(Continued from page 241)

eighths of the depth, and by 150 pounds per square inch—the shearing value of reinforced concrete—should equal this.

$160 \times d \times 7/8 \times 150 = 721{,}400.$

$d = (721{,}400 \times 8) \div (150 \times 160 \times 7) = 34.3$ inches.

This is greater than the depth found above and so the total depth will be 3 feet and 3 inches.

The next item to be investigated will be the amount of steel necessary for reinforcing. For this the familiar formula—$M = S \times 7/8\ d$—will be used. $4{,}874{,}700 = S \times 7/8 \times 34.3$. $S = 162{,}420.0$ pounds. The allowable tensile strength of steel is 16,000 pounds per square inch, and the number of square inches of steel necessary will be $162{,}420 \div 16{,}000 = 10.15$ square inches. There will be eighteen ¾-inch square bars used to make up this reinforcing. There will be needed fifteen ¾-inch square bars to reinforce the footing in the direction parallel to the long dimension.

The check mentioned in the last article for diagonal tension can be applied to this problem. In the elevation of this footing, shown in Fig. 95, a 45-degree line is dropped from the point of intersection of the pier with the horizontal surface at the top of the footing. The point of intersection of this line with the line of the steel is at a distance of 34.3 inches away from the pier. The distance from A to B (Fig. 95) is $34.3 + 50 + 34.3 = 118.6$ inches, or 9.88 feet, and the distance between the points of intersection on the short side of the footing is $34.3 + 30 + 34.3 = 98.6$ inches, or 8.21 feet. The area enclosed within these lines of intersection will be $9.88 \times 8.21 = 81.1$ square feet. The total area of the footing is 106.32 square feet and the area outside of the lines of intersection will be $106.32 - 81.11 = 25.21$ square feet.

The pressure per square foot is 7,520 pounds and the pressure on 25.21 square feet will be $7{,}520 \times 25.21 = 189{,}600$ pounds.

The distance around on the line of intersection is $2 \times (98.6 + 81.11) = 359.4$ inches, and this distance, multiplied by seven-eighths of the depth at this point and by 40 pounds per square inch—the allowable shear on concrete without considering the reinforcing—should equal, or be more than, 189,600 pounds. The depth at this point is unknown but can be found as follows:

$d \times 7/8 \times 40 \times 359.4 = 189{,}600.$

$d = (189{,}600 \times 8) \div (40 \times 359.4 \times 7) = 15.07$ inches.

By referring to Fig. 95, it can be found that this depth at the point of intersection determines the slope of the upper surfaces of the footing. If the vertical surface at the outside edges of the footing had been made only 6 inches high, the thickness of the concrete above the points of intersection would have been too small.

This type of footing is often found under outside columns where there is no restriction imposed to limit the dimensions of the footing. It will be noticed that the length of the steel bars in the footing is determined by the point of intersection of the 45 degree line with the line of steel. The distance between this point and the outside line of the footing is divided into two equal parts and the steel is brought up to this centre point.

A rectangular footing under steel grillage beams is worked out in a different manner. It may be remembered that the formula $M = \frac{1}{8}W\ (l - a)$ was given in previous articles for the purpose of determining the bending moment in the design of grillage beams. In Fig. 96 the letter L is used to represent the length of the concrete footing, and a is used to denote the width of the steel grillage beams. Another letter —b—is used for the breadth of the footing and l and b are found by determining the area of the soil necessary to support the load—W—proportioning the length of the sides to give the proper area. If the soil is 4-ton soil, then W may be devided by this and the footing made square or rectangular to suit the building conditions.

The tendency toward bending must then be figured, and

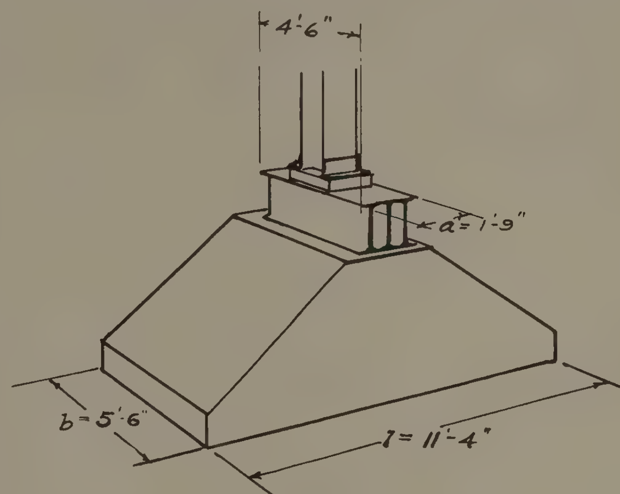


FIGURE 96

in order to find this tendency the formula given above is used. $M = \frac{1}{8}W\ (l - a)$. If W is measured in *thousands of pounds,* as it usually is in modern engineering practice, and l and a are measured in feet, the answer will give the moment in thousands of foot-pounds. In order to reduce this to inch-pounds it will be necessary to multiply by 12 or, $M = 12/8 \times W \times (l - a)$. This is the moment in thousands of inch-pounds for the entire breadth of the footing and if it were desired to find the moment for one foot of the footing it will be necessary to divide this by b. This makes the formula

$$M = \frac{12 \times W \times (l - a)}{8\ b}$$

As was pointed out in Article XIII, $M = 1{,}462.5 \times 7/8 \times d^2$, and if the bending moment is to be expressed in *thousands* of inch-pounds this formula then becomes $M = 1.4625 \times 7/8 \times d^2$.

In order to find the depth of the footing these two formulas may be equated.

$$M = \frac{12 \times W \times (l - a)}{8b} = \frac{1.4625 \times 7 \times d^2}{8}$$

$$d^2 = \frac{12 \times W \times (l - a)}{b \times 1.4625 \times 7}$$

$$d^2 = \frac{W \times (l - a)}{b \times .853}$$

This last formula is a very convenient one for the purpose of finding the depth of the concrete under a steel grillage footing. Its use may be made clear by means of an example.

Suppose it is necessary to support a steel column by means of steel grillage beams resting on a concrete footing, and this in turn rests upon soil having a bearing capacity of 4 tons, or 8,000 pounds, per square foot. Assuming that the load to be carried by the column at its base is 500,000 pounds, and that this base rests upon 4-ton soil, the number of square feet of soil that must be covered will be $500{,}000 \div 8{,}000 = 62.5$, and this area may be made up by having the concrete slab under the steel beams 5 feet and 6 inches wide, and 11 feet and 4

(Continued page 245)

HOUSE, T. R. VAN BOSKERCK, PLAINFIELD, N. J.

Marsh & Gette, Architects.

(Continued from page 243)

inches long. The steel will be considered as made up of six channels, back to back, covering an area 4 feet and 6 inches by 1 foot and 9 inches. By referring to Fig. 96, it will be seen that the letters l, a and b are now represented by the following dimensions: $l = 11$ feet and 4 inches, or 11.33 feet, $a = 1.75$ feet, and $b = 5.5$ feet.

By substituting in the formula the following result will be obtained.

$$d^2 = \frac{500 \times (11.33 - 1.75)}{5.5 \times .853}$$

$$d^2 = 1020$$

$$d = 32$$

This depth must be checked for shear and the area of steel determined, but the methods already given can be used for these purposes.

If a square base is to be designed then the constant changes as the formula for bending for a square footing is $M = 1/12 \times W \times (l - a)$. This may be equated with the formula for depth as before, first multiplying by 12 to reduce the moment to inch-pounds.

$$M = \frac{12 \times W \times (l - a)}{12b} = 1.4625 \times 7 \times d^2$$

$$d^2 = \frac{b \times 1.4625 \times 7}{8 \times W \times (l - a)}$$

$$d^2 = \frac{W \times (l - a)}{b \times 1.2797}$$

It may be noticed that this constant is one and one-half times as large as the one obtained before—.853, and may be used in the following manner.

Assuming a load of 800,000 pounds, which is brought to the footing by an interior column which first rests upon steel grillage beams covering an area of 3.75 feet square. If the soil is capable of carrying 4 tons per square foot, the area of concrete under the grillage will be 10 feet square, and by substituting in the formula d can be found.

$$d^2 = \frac{800 \times (10 - 3.75)}{3.75 \times 1.2797}$$

$$d^2 = 1042$$

$$d = 32.28$$

This depth will be found to be great enough to withstand the tendency toward punching shear, and can be used to determine the area of steel necessary to withstand bending.

A type of footing that is often encountered in concrete work is the type that rests upon piles. Section 235 of the New York Building Code gives the allowable loads and for the purposes of this article the load allowed on each pile will be 20 tons or 40,000 pounds. If the load brought by the column is considered as 800,000 pounds and the weight of the footing itself as 40,000 pounds, the total weight on the piles will be 840,000 pounds. By dividing this load by 40,000 the number of piles—21—is obtained.

Engineers have determined the best method of arranging piles, and the arrangement shown in Fig 97 is about the best for this number. It will be noticed that the outside dimensions of the footing are 9½ feet by 9½ feet, and that the piles are spaced 2 feet on centres, although the law allows a minimum spacing of 20 inches.

As in Article XVI, the circular column is replaced by a square, known as the equivalent square, and having a side equal to seven-tenths of the diameter of the circle. This square has sides 1 foot and 10 inches in length and the distance from the edge of the square to the first line of piles is 1 foot and 1 inch. The distance to the second line is 2 feet and 10 inches. In the formula, determined in the following paragraph, the first distance will be designated as x and the second as y.

Consider the footing divided into four parts by means of diagonals. In each of the fourths, on the x line, there is one full pile and two half piles making a total of two piles to be considered, and on the y line there are three piles. If P is taken as the value of a single pile the moment around the edge of the equivalent square will be given by the formula $M = P(2x + 3y)$.

The value of P will be found by dividing 800,000 by 21 as the weight of the footing will not produce any tendency in the footing toward bending. $800,000 \div 21 = 38,000$ pounds. The value of M will therefore be found as follows:

$2 \times 13 \times 38,000 = 988,000$ inch-pounds.
$3 \times 34 \times 38,000 = 3,876,000$ " "
4,864,000 " "

The depth of the footing will be determined for bending

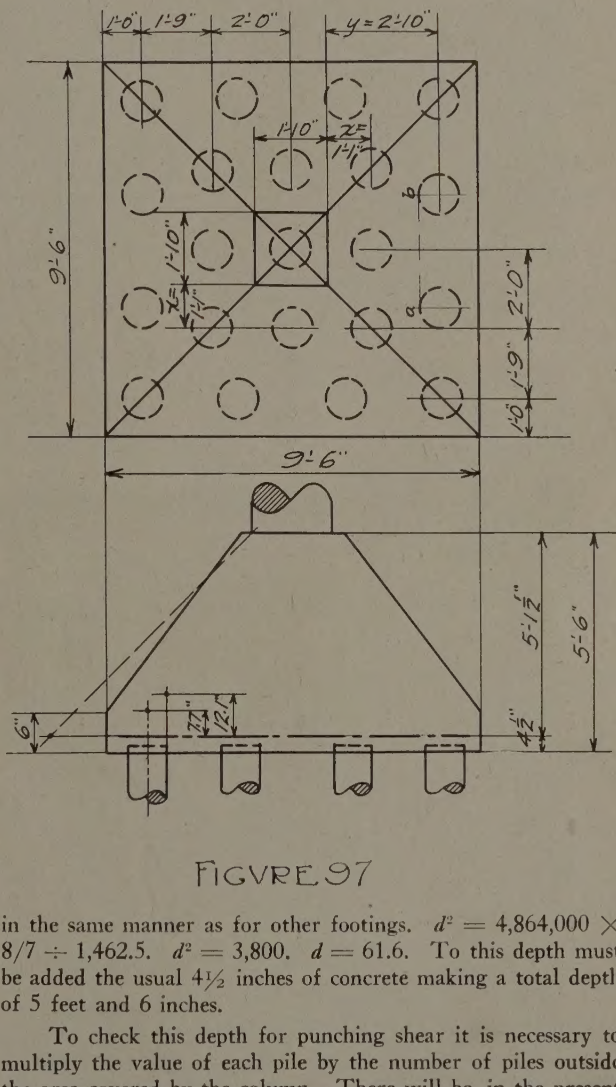
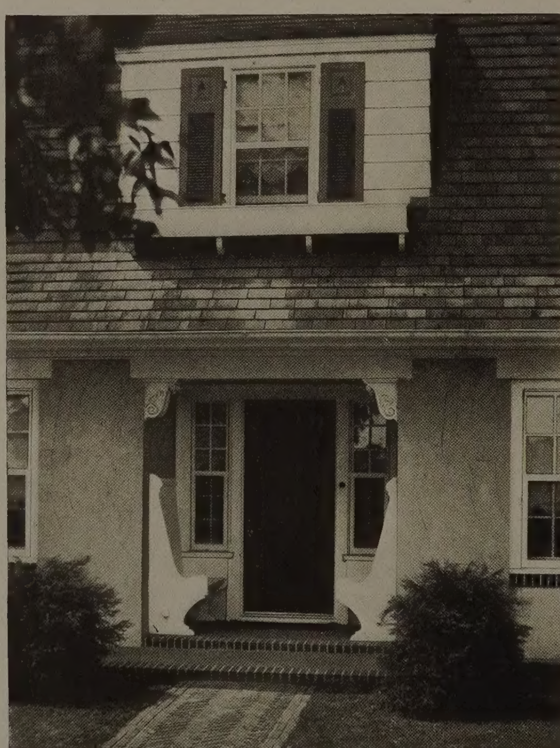


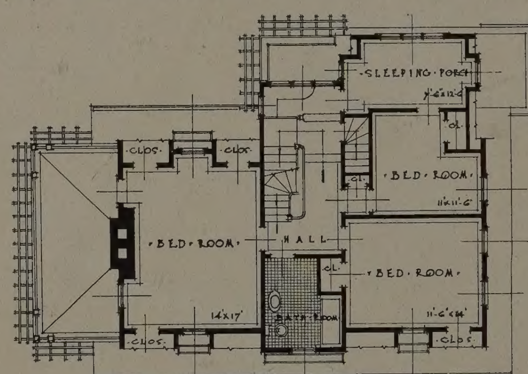
FIGURE 97

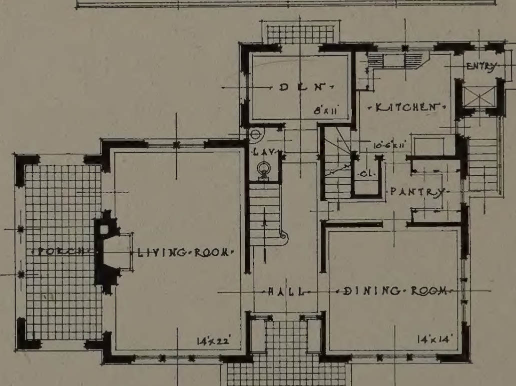
in the same manner as for other footings. $d^2 = 4,864,000 \times 8/7 \div 1,462.5$. $d^2 = 3,800$. $d = 61.6$. To this depth must be added the usual 4½ inches of concrete making a total depth of 5 feet and 6 inches.

To check this depth for punching shear it is necessary to multiply the value of each pile by the number of piles outside the area covered by the column. There will be, in the present case, 20 piles outside of this area, and as the value of each pile is 38,000 pounds, the punching shear will be $38,000 \times 20 = 760,000$ pounds. The diameter of the column is 31 inches and the circumference is 97.4 inches. This circumfer-

(Continued page 247)







HOUSE, H. M. GREEN, KEW GARDENS, LONG ISLAND.

Walter McQuade, Architect.

(*Continued from page 245*)

ence, multiplied by 7/8 d, and by 150—the shearing value of reinforced concrete—should equal 760,000 pounds.

$d \times 7/8 \times 97.4 \times 150 = 760{,}000.$

$d = 760{,}000 \times 8 \div (97.4 \times 7 \times 150).$

$d = 59.4.$

As this d is less than the one found for bending the depth will be made 5 feet and 6 inches as before.

In order to check for diagonal tension the process outlined in Article XVI should be used. Draw a 45-degree line from the point where the column intersects the horizontal surface at the top of the footing to the line of the steel. In the present case this line intersects the steel line outside of the footing (Fig. 97) and so there is no danger of diagonal shear, but in case the 45 degree line should intersect the steel line inside of the footing, then the number of piles that would come outside of this line of intersection should be counted and this number multiplied by the value of a single pile. This will give the force tending to produce failure through diagonal shear and there should be a proper thickness of concrete *above* the steel at the point of intersection to withstand this force. The method of determining this depth can be found in Article XVI.

Another item to be investigated is the amount of concrete over the outside piles. There should be a sufficient thickness to insure against the punching out of the concrete, which might be caused by the upward pressure of the pile. This upward pressure was found to be 38,000 pounds. The diameter of the upper end of the pile will be taken as 12 inches, and the circumference will be 37.7 inches. The thickness of concrete over the centre of the outside piles must be found in the following manner.

$$d^1 = \frac{38{,}000}{7/8 \times 150 \times 37.7} = 7.7 \text{ inches.}$$

In the present case the thickness of concrete on a line connecting points a and b (Fig. 97) should also be investigated. The length of this line is 24 inches as the piles are spaced 2 feet on centres, and the thickness along it can be found by using the same formula as above.

$$d^1 = \frac{38{,}000}{7/8 \times 150 \times 24.0} = 12.1 \text{ inches.}$$

The six-inch height will govern the design of the footing, rather than the ones found above.

The United States Post Office and Court House Denver, Colorado

By Egerton Swartwout

THE United States Post Office and Court House at Denver, Col., which is illustrated in this number of ARCHITECTURE, was won in competition in the spring of 1909 by the then existing firm of Tracy, Swartwout & Litchfield. The working drawings for the exterior and for such other work as was included in the first contract were completed in the fall of that year, but the contract itself was not let by the Government until the spring of 1910. This contract was completed in approximately schedule time, but after its completion work was entirely suspended for a considerable period, pending the passage by Congress of an additional appropriation. Finally, in 1914, the contract for the interiors and the general completion of the building was let and the Government assumed possession of the building early in 1916.

In general arrangement, the building as built adheres very closely to the scheme presented in competition, with the exception that while in the competition scheme there were two separate open courts above the workroom, in the building as built it was not found necessary to continue the circulation through this connecting link on the third and fourth floors, thus permitting a closed E-shaped plan, which added greatly to the appearance of the court and to the amount of light and air available for the rooms facing on it. A rather interesting feature of the court treatment was the recognition of the fact that as the court was surrounded practically on three sides by a public corridor, its walls would acquire almost an equal importance with the exterior of the building and, therefore, the treatment of the court walls was made fully as elaborate as the treatment of the exterior, with the exception that they were faced with limestone, instead of marble; and it was further realized that as the court could not be seen in connection with the exterior, its scale should approximate the scale of the court rooms and corridors on the interior of the building, rather than be governed by the scale of the exterior, which was fixed by the height of the main order. This order, which is 44 feet high, was indicated on the competition drawings as similar to the Erechtheion, and the whole building had a somewhat Greek feeling, if indeed such a feeling can be expressed at the customary small scale of competition drawings. As the working drawings were developed, I found it absolutely impossible to adapt a strictly Greek order to the exigencies of a modern building. It is a practice to which I had always been opposed, but in the present instance I was a little uncertain as to what latitude would be allowed by the Government in any radical change in exterior design. Consequently, numerous studies were made and abandoned, and finally it seemed advisable to throw precedent to the winds and adopt a free form of Ionic order which would permit of more freedom in detail. While retaining the principle of the decorated necking of the Erechtheion, the scale was made much larger, and the national coat-of-arms, with the eagle and shield, substituted for the anthemium motive. The slight dip in the wings of the eagle, which is shown in

the detailed illustration of the cap, coincides with the dip of the line connecting the volutes which is customary in Greek work, and the projecting top of the wings gives a very pleasing and interesting shadow at this point. The feathers of the wings were modeled as apparently bent over the moulding of the echinus. This, while not so perceptible in the photograph as it is in the actual cap, gives a feeling of continuity to the cap, and is distinctly an improvement. The eagle motive was used to a considerable extent, noatbly in the frieze of the pylon caps, which is continued practically around the entire building.

I regret to say that the sculpture which was an important part of the design has never been executed. There were to be groups on the pedestals flanking the main portico, and also on the pedestals at the side entrances, and statues over the engaged porticos on 18th and 19th Streets, and also bas reliefs in the panels on the pylons and over the windows in the side elevation. We secured several estimates and preliminary sketches for this sculpture, but the Department at Washington seems at present opposed to that kind of embellishment for a public building, and I regret to say that no action has yet been taken. There is now a bill before Congress for the completion of this structure, and I hope that the representatives will be able to secure its passage, as the sculpture on this building is not merely an embellishment but an integral part of the design.

The exterior is of white Colorado marble, and is extremely beautiful in texture and color, the interior court, as I have before stated, being of Indiana limestone of buff and blue mixed.

It is greatly to be regretted that the site of the building was not better chosen. Unfortunately, it is merely a block in a rather sparsely built portion of the city and not at all connected with any park system nor with the proposed new civic development, which is now under way in the space fronting the State Capitol. Presumably, the property adjacent to the Post Office will increase in value, and undoubtedly tall and probably hideous commercial buildings will be erected around it. On account of the surroundings, it was very difficult to take a photograph of the exterior of the building that was not distorted, and therefore it was impossible to get a view showing the building in its entirety.

The competition program called for three court rooms on the second floor, the Circuit Court, the District Court, and the Court of Appeals, and the arrangement of these three court rooms opening from the large corridor extending entirely across the front of the building on the second floor, was a distinctive feature of the plan, these court rooms being so arranged that the public entered in the front, while the judges, clerks and other court officials entered the court rooms from the rear, back of the bar. This arrangement was adhered to in the development of the plans for the first contract, but before the interiors were let, the Circuit Court was abolished, and we were instructed to put offices in the place of the centre court room. As the exterior floors and walls had been built, this was manifestly impossible, and the Government was induced to turn the central court, which was to have been the Court of Appeals, into a Law Library. This has worked out very well in construction, and being finished in oak, makes an interesting room, although as the Department of Justice in Denver at present has no books, it presents a rather uncompleted appearance.

An interesting feature in connection with the court rooms is that in the development of the scheme we were guided by the advice of Prof. Sabine of Harvard, who assumed entire charge of the acoustical work. In the District Court, the panels in the ceiling were covered with acoustical felt, as was also the niche behind the bench. The felt on the ceilings was covered by a membrane dyed approximately the color of the plaster work of the ceiling, stretched so as to reproduce in actual material the linen folds that are sometimes used as a decorative feature in plaster. This, on account of the size of the panels and their segmental shape, was an extremely difficult proposition, but was very well handled by the contractors, and the result was extremely satisfactory. The acoustical felt on the niche was covered by velvet hangings of a rich dark blue with gold trimmings. Unfortunately, this velvet shows in the photograph much darker than it is in reality. There was a similar treatment in the Court of Appeals, with the exception that the acoustical felt was applied entirely to the walls, and was covered in this case by hangings of velvet, and velvet curtains were also hung for acoustical purposes between the screens of columns at each end of the court room, the velvet in this case being a rich purple, with gold trimmings, which harmonizes well with the color of the marble columns and with the painted decoration of the ceiling.

The workroom is large and extremely well lighted, and was equipped under the plans supplied by the Governmnt, a feature of the arrangement of the workroom being a depressed runway to the mailing platform, accessible from both 18th and 19th Streets, this runway being covered for the greater part of its length by a terrace which extends entirely across the Champa Street façade. This arrangement was put in at the request of the property owners on Champa Street, who were unwilling to have an exposed mailing platform facing on that street. As it now exists, the objectionable features of the mailing platform are covered by the terrace, and will in the future be further concealed by the planting.

One very disappointing feature in the completion of the building was the fact that the Department did not feel able to entrust the electric fixtures and moveable furniture to this office. Although we offered to prepare the drawings and specifications for this work gratuitously to the Government, we were informed that our offer could not be accepted, on account of the fact that the appropriation for this work came from a different fund than the general appropriation for the building, and that, according to their regulations, this work must be handled by the department. The result is that, while the bench and bar and other fixed furniture in the Court of Appeals is of Circassian walnut, elaborately carved, and in keeping with the rest of the room, the benches, tables, etc., are bright golden oak, and very clumsy and crude in appearance, thus completely destroying the feeling of harmony which should exist between the fixed and moveable furniture. Similarly, the electric fixtures are not at all suitable in size or in point of design for the place in which they are placed. I mention this only as a criticism of the method under which Government officials are obliged to work, and the slight allowances which are appropriated for such a purpose.

No description of this building would be complete without reference to the work done by the artists and modelers who were associated with us. Mr. Schladermundt was entrusted by the Government with four mural paintings in the entrance lobbies to the main corridor, and the decoration of the two court rooms was under the direction of Mr. Rinschede. To the ability of Raphael Menconi, and his brother, Frank Menconi, is due the detail of the exterior, the interior models being made by Mr. Neumann.